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ANALYSES OF PLANS AND COSTS FOR DOMESTIC WATER SUPPLIES AND FARM BUILDINGS

Plan of Joint Investigations
Columbia Basin Irrigation Project
Problem 9

Preliminary Report

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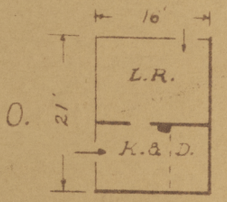
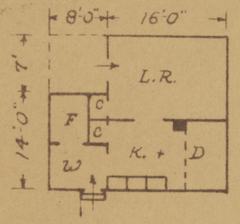
STAGE 1.	STAGE 2.	STAGE 3.	STAGE 4.
Showing Simple Arrangment of Spaces, Enclosed With Partitions for Privacy Only.	Stage 1. Designs Repeated With Storage Spaces and Work Porches Added.	Stage 2. Designs Repeated With Bathrooms added.	Indicating Location of Stairways. Plan 1x. Story and a half with possible Expansion Up-Stairs, and Laterally. Plan 2x Same. Plan 2c. Stairway to B.

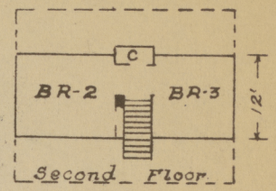
DIAGRAMATIC REPRESENTATION OF DEVELOPMENT OF THE DESIGN OF A FARMHOUSE

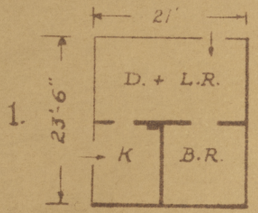
BASED ON RECOMMENDED MINIMUM SPACE REQUIREMENTS, ONE CHIMNEY, CONCENTRATED PLUMBING AND CONTINUOUS HORIZONTAL ROOF RIDGE.

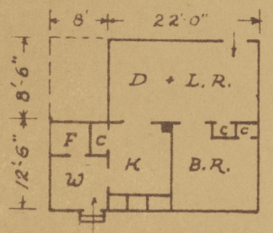
LEGEND: NUMBERS TO LEFT OF "STAGE 1" COLUMN INDICATE NUMBER OF BEDROOMS. DOTTED LINES SHOW HOW BEDROOMS AND PORCHES CAN BE ADDED AT MINIMUM EXPENSE, WITHOUT DESTROYING THE SYMMETRY OF THE PLAN.
L.R. - LIVING ROOM; D. - DINING ROOM; K. - KITCHEN; B.R. - BEDROOM; B. - BATH; W. - WORK PORCH; H. - HALL; F. - FOOD STORAGE; C.-CLOSETS; ■ - CHIMNEY; □□□ - CUPBOARDS

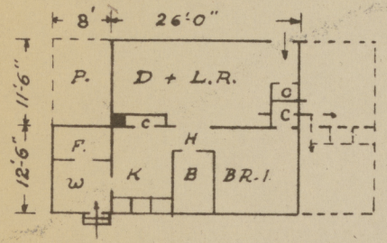


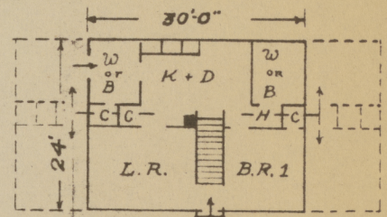


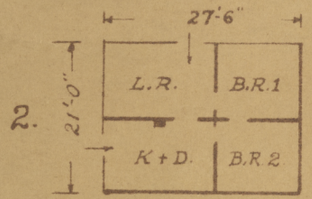


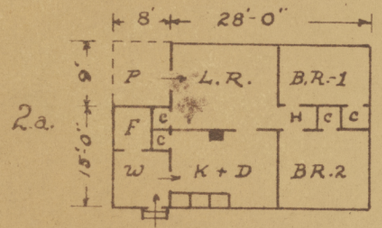


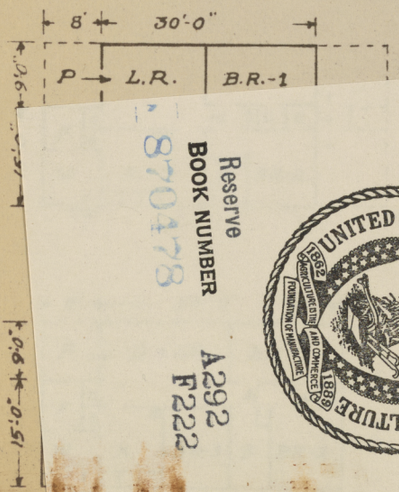


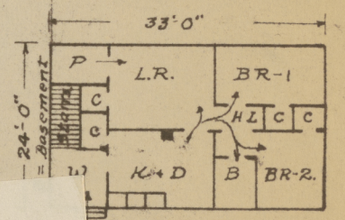


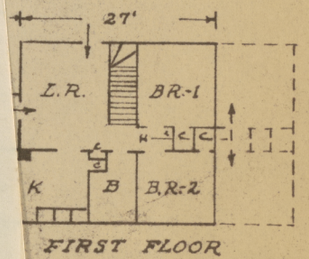


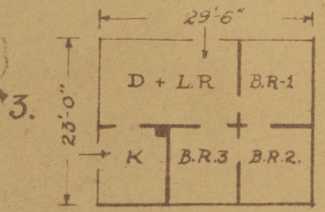


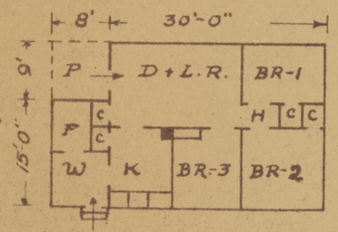


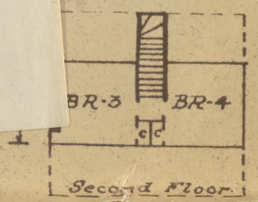












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4 Preliminary Report

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ANALYSES OF PLANS AND COSTS

FOR

DOMESTIC WATER SUPPLIES AND FARM BUILDINGS

Plan of Joint Investigations
Columbia Basin Irrigation Project
Problem 9

870478

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- Prepared by the Farm Security Administration, Region XI -

The Problem: "What feasible means could be adapted or created (a) to help insure an adequate standard of living and (b) to minimize the financial commitments of needy settlers in providing suitable and essential improvements? Essential improvements include, of course, land leveling, farm ditches, houses, stock, wells or other sources of water for domestic use and for stock, and implements. Means of minimizing the initial investment in them might include such diversified aids as heavy leveling on a large scale; acquisition by cooperative organizations of heavy machinery for use at cost by member farmers; the design of inexpensive houses of materials and styles suited to the climate and mode of life involved; houses to the first units of which harmonious additions could later be made by the owners; facilities for purchase of building materials at low unit cost; provisions to pipe water under pressure from a single well to the common corners of several farm units at or near which the buildings of the group of farms might be clustered conveniently to effectuate various economies and conveniences; and procurement at cost from the Clarke-McNary Nursery of Pullman or from other nurseries of trees and shrubs for the homesteads."

The farmstead is the main office of the business of farming, the concentration plant, the storage and work shop area, as well as the home. The theoretical and practical balance of these two functions therefore becomes involved and intricate, and demands intelligent correlating of the elements which influence its design and policy. Confronted with such a problem, it is obvious that planning an area comprising many new farmsteads, offers the widest range of opportunity for demonstrating the principles which govern good planning from an aesthetic and functional viewpoint. In the present instance this challenge must be met with plans and suggestions that are adequate and practical. In preparation of this report we have therefore striven constantly to keep in mind adequacy, simplicity, and good planning.

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First, a determination must be made of what improvements are to be defined as suitable and essential to help insure an adequate standard of

living, and second, what means can be adopted to minimize the financial commitments to provide them.

The recognized order of importance of improvements to the farm is as follows:

(1) Subdivision of the land

(2) Provision of domestic and stock water supply

(3) Selection of the site of the farmstead

(4) Land clearing and leveling

(5) Provision of farm irrigation structures, laterals and drainage ditches

(6) Construction of the house

(7) Construction of stock shelters

(8) Construction of outbuildings

As 1, 3, 4, and 5 are being reported on by other committees; the purpose of this report will be to present an analysis of the cost and possible methods that can be adopted to provide water supplies and to construct the farm buildings.

DOMESTIC AND LIVESTOCK WATER SUPPLY

The supply of water for domestic and livestock use is placed first in importance, because on it not only depends the existence of the farm, but the source, quality and abundance of the supply is the chief factor controlling the design of the subdivisions of the land and the location of the farmstead.

There are two possible sources of water available in this area, from irrigation ditches and from drilled wells. Water could be supplied from irrigation ditches if it were first passed through filter beds and then stored in underground cisterns. This method will have to be eliminated from consideration on this project due to the winter climate, however, as no water will be in the canals during the period between growing seasons. It would be impracticable to provide individual cisterns to store sufficient water to carry over this period, and to haul water would be inconvenient and expensive.

The other alternative is obtaining water from drilled wells. This source of water is dependent on underground waters, the occurrence, movements, quantities and qualities of which are assigned for special study by the committee on Problem 22. It is not intended to infringe on the investigations of this Committee. The comments included herein are to supplement

this phase of the investigation.

The planning of subdivisions and the locating of towns and communities without a reasonable certainity of an adequate and economical water supply to serve the inhabitants is a hazardous and very expensive undertaking that can ruin a budget more completely than any other single item of rural planning. The cost of drilling a well is also the most uncertain item of farm improvements, because it involves unknown and variable factors. The cost of drilling and casing varies with the geological formations and the depth of the well, and the cost of the pumping equipment varies with the depth to the water and the amount of water to be pumped in a specified time. Whether water is present of a suitable quality and quantity, or whether any water will be encountered at all, is problematical from the start.

Since, however, one phase of Problem 9 is to suggest the feasible means that can be adopted or created to minimize the financial commitments for providing essential improvements, the probable range of costs of drilling and casing a well, and of installing an automatic pump with pressure tank (which will be necessary if baths are desired in the houses and running water is essential to the livestock) will be presented here, based on data at hand.

First, it is assumed that most of the wells will vary in depth from 150' to 450'. This information is taken from a letter by N. C. Jannsen of the N. C. Jannsen Drilling Company of Seattle, Washington, to Mr. P. Hetherton of the Washington State Planning Council on September 10, 1940, a copy of which is attached. This company has drilled many wells in and around the proposed project area and have published a report on ground water conditions in the state of Washington to the Division of Water Resources, State Planning Council. From information given in this report some wells will undoubtedly be drilled to 1000 feet. Therefore, practically all wells will have deep well pumping equipment, except in rare instances where the water will rise to within 20 feet of the top of the ground, in which cases shallow well or suction pumps can be used.

From narrative description and logs of wells in the area, contained in the above mentioned report, considerable amount of drilling will be through rock. Because of the formation, an 8" well is recommended, in order to insure a straight hole. Another reason warranting an 8" hole is the necessary practice of reducing the size of the casing as the depth increases. Not knowing when beginning a well how deep it is to water,

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an 8" hole is the minimum safest size for the hole in order to insure a diameter, at the water level, sufficient to receive the drop pipe and cylinder.

Next, it is assumed that the essential minimum capacity of both the well and the pump shall be five (5) gallons of water per minute, or three hundred (300) gallons per hour per family. This assumption is based on a discharge capacity of a 3/4 hose nozzle of 275 to 300 gallons per hour, which is important for fire protection, and this quantity makes it possible to have two ½ inch outlets open simultaneously without a serious failure of water at either outlet. This amount of water is ample to serve the daily requirements of the family and livestock, based on figures that have been accepted by the National Association of Water Systems Manufacturers, and limits the operation of the pump to about two hours a day. The minimum capacity of domestic pumps is about three gallons a minute, but the difference in cost between this pump and one of five gallons capacity is so little that no economy is attained.

The estimated cost of $5.00 per foot estimated in the above mentioned Jannsen letter compares favorably with bid prices received by FSA for drilling similar sized wells in Boundary County, Idaho, where evidence at hand also indicated that considerable rock would be encountered. The Jannsen estimate of $5.00 per foot did not mention the inclusion of the well casing, which will be necessary in strata other than rock, so for estimating purposes a basic price of $6.00 per foot for the entire depth of the well will be used for estimating the cost of drilling and casing an 8" diameter well.

To equip this well with a deep well pump to lift water from a certain depth at the rate of 500 gallons an hour would involve additional cost.

Setting up this data in tabular form for the probable depth of the average wells and using current list prices of pumping equipment, the results are as follows:

Gals. Per Hour.	Depth to Water	Pressure Tank Capacity	Well Size	Drop Pipe Size	Cost Max. Length Drop Pipe	Maximum Cost Water Supply			
						Pump Unit	Well Depth	Cost at $6.00 Ft.	Total Cost
245	36'-100'	42 Gal.	8"	2½"	$25.00	$180	150'	$900.00	$1080.00
300	101'-190'	"	8"	2"	40.00	328	250'	1500.00	1828.00
300	191'-350'	"	8"	2"	70.00	380	350'	2100.00	2480.00
300	351'-380'	"	8"	2"	76.00	455	450'	2700.00	3155.00

From this it is seen that the costs for even the wells of 150 foot depth may be distressingly high. Also the greater the depth, the more expensive the pumping equipment becomes.

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300	101'-150'	"	8"	2"	40.00	325	250'	1500.00	1838.00
200	151'-250'	"	8"	2"	70.00	380	350'	2100.00	2480.00
300	251'-350'	"	8"	2"	76.00	455	450'	2700.00	3165.00

A water supply for each farm from individual wells, would be a large item of expense and, therefore, justifies a study of the ways and means of reducing this cost to a minimum. There are three ways open which might lead to a saving in the cost of this improvement:

(1) The possible ways and means of reducing the cost of drilling.

(2) The methods of buying to lower the cost of the equipment (casing, pump, etc.), and

(3) The possibility of serving more than one farm from one well, thereby prorating the cost of each water system among several farmers.

(1) Reducing the cost of drilling. The large number of wells to be drilled in this area suggests the possibility of using cooperatively or government owned well drilling equipment, or letting the work under contract as per specifications. The best way to arrive at a decision as to which of those methods is the more economical and practical, is to set up a tentative schedule of the work involved and the time alloted to perform it.

It is estimated that the area when fully developed will establish from 20,000 to 30,000 new farms. To settle the area will take about twenty years. Assuming from the data to follow, that on an average one well will serve four farms, and allowing the difference between 20,000 and 30,000 farms for concentrated communities, it will take 5,000 wells to serve 20,000 farms.

From the information supplied by A. A. Durand and Son, well drillers, it is impossible to estimate the length of time required to drill a well. We believe, however, for estimating purposes, that the average time consumed to set up, drill, develop, and case a well in the rock formation which will be encountered will be three (3) weeks, allowing for repairs and possible failures. This means that one drilling outfit can drill about seventeen (17) wells a year.

Assuming also that the rate of development is uniform over the twenty year period, the number of new farms coming into existence each year would be 1,000 farms. More than likely the rate of development will be much more rapid than this for part of the period. For estimation purposes the 1,000 farms per year will be used. This would involve the drilling of 250 wells per year if on the average, one well served 4 farms and 15 well drilling outfits to do the work. For the reason, as stated before, that the water supply should be the first improvement on the farm, because on it depends the location of other improvements, the well drilling operation should proceed in advance of other improvements and,

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therefore, will require more rapid progress than estimated above. To put 15 well drilling rigs to work can be done by inviting bids under specifications, and awarding contracts to firms specializing in this business. Or cooperatives can be organized and the equipment purchased from funds loaned by the Government. This latter method is more efficient and less cumbersome than renting Government owned equipment to users, because of delays and uncertainties caused by government procurement procedure in purchasing supplies and parts (in break-down emergencies). Well drilling cooperatives would simplify this function and relieve the government of considerable supervision and accounting. Well drilling equipment is subject to constant repair.

A well drilling outfit suitable for drilling 8" wells in the formation predominant in this area will have to be a sturdy type. A complete outfit includes the drilling machine; several sets of drills to keep one in operation, as rock drilling requires constant drill sharpening; a mounted water tank; a truck for hauling water; supplies; fuel and casing; and several other types of tools, such as used for perforating, baling, drill sharpening, withdrawing casing, recovering lost tools, pumps for testing, etc. The cost of drills and miscellaneous tools is ofter more than that of the drilling machine.

The whole outfit involves a considerable investment which would increase as new exigencies arose requiring special tools. It would take a well driller of long experience to anticipate the equipment requirements, but to give some idea of the initial capital outlay that will be required per outfit, there is attached a catalog of well drilling equipment. It is estimated that one complete outfit would cost about $4500.00. Some serious difficulty may arise in hiring experienced well drillers and tool sharpeners, as the type of mechanics needed for this job are either employed by well drilling companies or have rigs of their own. It was for these reasons, plus the relief from supervising the maintenance and operations of such a scattered type of construction, that convinced the Engineering Division of the FSA to contract all deep well drilling on all projects. This method places all responsibility of the operation on the contractor, and facilitates any increase desired in production. A copy of a deep well drilling specification is herewith attached.

(2) Methods of buying. On the other hand, the FSA has encouraged the cooperative buying of equipment, such as well casing and pumping units. Bids on carload lots are invited by the cooperative. In the same way, the furnishing and installation of complete pumping equipment is contracted

for several wells at one time, by listing the necessary data for each well in the specifications. A copy of the specifications by which several pump units were purchased in this manner for several farms at the FSA Project at Bonners Ferry, Idaho, is attached. A saving on pipe and pumping units will range between 25% and 40% of catalogue list prices.

(3) Serving several farmsteads from one well. The greatest opportunity of reducing the cost of the water supply per farm lies in the possibilities of piping water from one well to two or more farmsteads (up to and including eight) in other than concentrated communities. The reason for placing the limit of eight farmsteads from one well is because it has already been generally accepted that the size of the usual farm will be about eighty (80) acres, which means that a square mile will embrace an average of eight farms, and there is a likelihood that more wells will have a capacity of forty (40) gallons per minute or less, than over that amount. If the requirement of one farm is five (5) gallons per minute, a well and pump to supply eight farms would have to be forty (40) gallons per minute. Most manufacturers standardize their automatic pressure system requirement within these limits.

Of course, the capacity of the well will determine how many farmsteads can be served. Undoubtedly most of the roads and farm boundaries will adhere to the section lines, except where characteristics of the topography cause deviations. Since each farmstead is served by a road, the road right of way can be used as the right of way for pipe lines, thereby eliminating separate easements. A mile of 3" Galvanized steel pipe or "Transite" pipe will conduct twenty (20) gallons a minute with a friction loss of only 7 . lbs. pressure, which means that it can serve four farmsteads a mile distant from the well with a pressure range between 13 lbs. and 33 lbs. The standard pressure range of most domestic equipment is 20 to 40 lbs.; however, the decrease in pressure caused by pipe line friction when not too serious, can be rectified by increasing the pressure range of the pump from 30 to 50 lbs. with little added expense.

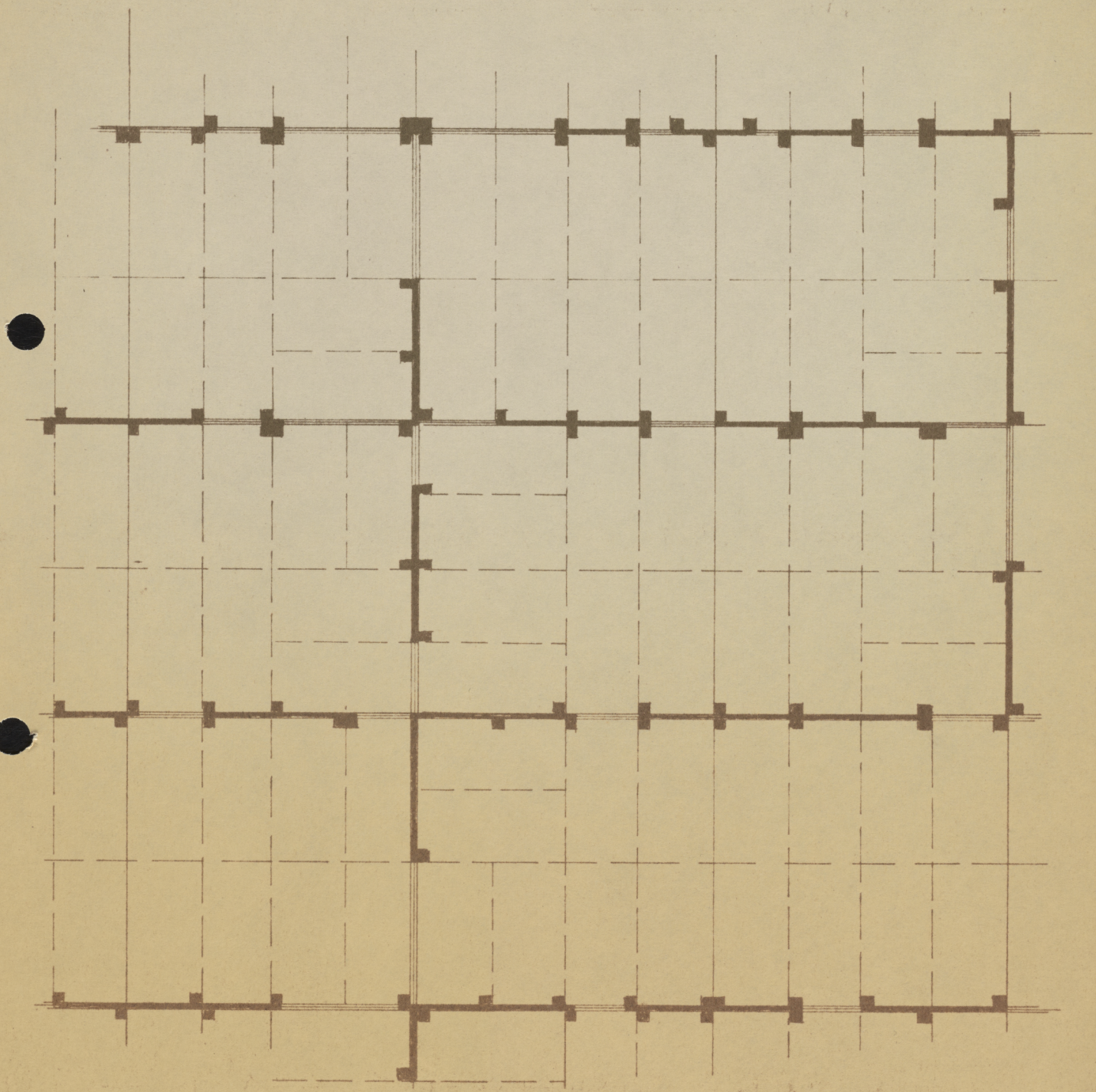
A well of forty (40) gallons capacity can, therefore, serve eight (8) farmsteads provided the well is so located in relation to the farmsteads, that no more than four (4) farmsteads are on a mile of 3" pipe. How any combination of from one to two and including eight (8) eighty-acre farms can be supplied with water and using roadways for right of ways for pipe lines is best understood by examining the accompanying diagramatic sectionized map.

DIAGRAMATIC MAP OF LAND DIVIDED INTO SECTIONS

DEMONSTRATING THE POSSIBILITY OF SERVING TWO TO EIGHT, EIGHTY ACRE FARMS WITH A MILE OR LESS OF PIPE LINES FROM A COMMON WELL.

■ = FARMSTEAD; ═══ ROADS; ——— SECTION LINES; - - - FARM LINES

——— PIPE LINES



To connect more than eight farms to one well would increase the pipe sizes and thereby reach the point of diminishing return. This can be more clearly understood by examining the accompanying tabulation, which shows the comparative costs of an individual water supply to one farm with the prorated cost to each of several farms piped from one well. All prices are based on current list prices of equipment and car load lot prices of pipe.

The first four lines of columns, 1 to 11 inclusive, are a repetition of the figures already given for drilling and equipping one well. Thus to provide a 150 ft. well and provide a pumping unit to pump 245 gallons an hour from a depth of 36' to 100' would cost $1080. A well of 250' with equipment to pump the same amount of water from a depth of 101' to 190' would cost $1828, and so on, as shown in column 11. The other figures in column 11 show how the cost increases as the capacity of the pump increases to serve, 2, 3, 4, 5, 6, 7, and 8 farms. The figures contained in columns 2 to 10, inclusive, are the data on which the costs of column 11 have been determined.

Now, in order to ascertain whether it is more economical to run the risk of drilling additional wells on farms adjacent to one on which a well has already been proven, or connect these farmsteads to the original well by pipe lines, there has been added to the above tabulations, in columns 12 to 19 inclusive, the cost of supplying and laying $\frac{1}{4}$, $\frac{1}{2}$, 3/4 and one mile of pipe respectively. As the region experiences some severe winter weather at times, water lines should be protected with a coverage of $3\frac{1}{2}$' to 4'.

Thus the cost of digging by hand labor a $\frac{1}{4}$ mile of trench 4' deep, laying the $1\frac{1}{2}$" galvanized pipe and back-filling, is $594.00, given in column 13. The data given in column 12 is the basis of arriving at this figure.

Referring to the typical sectionized map, it is readily seen that each 80-acre farm contained in a section is about $\frac{1}{4}$ mile wide and $\frac{1}{2}$ mile long. This arrangement makes it impossible to serve more than four farmsteads with a $\frac{1}{4}$ mile of pipe. To serve more than four farms from one well will, therefore, take longer pipe lines, so the additional cost data for $\frac{1}{2}$, 3/4 and a mile of water mains have been added. Of course, there will be intermediate distances actually encountered, but the distances chosen are for the conveniences of comparison.

The figures shown in column 13 are the prorated costs to each farm

TABULATION – COMPARING THE COST OF A WATER SUPPLY TO ONE FARM FROM A WELL TO THE PRO RATED COST TO EACH OF SEVERAL FARMS PIPED FROM ONE WELL

ESTIMATED COST OF DRILLING AND CASING WELLS AND EQUIPPING WITH PUMP UNIT FOR VARIOUS REQUIRED CAPACITIES — MAXIMUM PRORATED EQUAL

1	2	3	4	5	6	7	8	9	10	11	12	13
NO. OF FARMS	GALS. PR. HR.	DEPTH TO WATER	TANK SIZE GALS.	WELL SIZE	DROP PIPE SIZE	COST MAX. LGTH. DROP PIPE	EXTRA COST LARGER TANK	MAXIMUM COST WATER SUPPLY *PUMP UNIT	WELL $6. PR. FOOT	TOTAL	DATA	COST ¼ MILE
1	245	36'–100'	42	8"	2¼"	$ 25.	–	(1) $180.	150' $ 900	$1080	Depth of Trench 4'	Based on
1	300	101'–190'	42	8"	2"	40.	–	(2) 328.	250' 1500	1828	Dug by hand $.20 ft.	1½" G. Pipe
1	300	191'–350'	42	8"	2"	70.	–	(3) 380.	350' 2100	2480	Laying & Backfill .10 ft.	@ .15 ft.
1	300	351'–380'	42	8"	2"	76.	–	(4) 455.	450' 2700	3155	Friction Loss 3# (5 GPM)	$594.00
											Machine Trenching .02'	
2	690	40'– 90'	82	8"	3"	40.	$15.	327.	150' 900	1227	Deduct for 1½" Pipe 27	$911.00
2	690	91'–125'	82	8"	3"	50.	15.	354.	200' 1200	1554	Friction Loss 6# (5 GPM)	1074.00
2	690	126'–175'	82	8"	3"	70.	15.	401.	250' 1500	1901	" " 21# (10 GPM)	1248.00
2	690	176'–240'	82	8"	3"	96.	15.	466.	300' 1800	2266	Deduct for Machine	1430.00
2	690	241'–380'	82	8"	3"	152.	15.	570.	450' 2700	3270	Trenching $119	1932.00
3	970	66'–100'	120	8"	3½"	45.	30.	377.	150' 900	1277	Friction Loss 2" Pipe, 1# (10 GPM)	634.00
3	970	101'–160'	120	8"	3½"	72.	30.	440.	250' 1500	1940	Friction Loss 1½" Pipe 10# (10 GPM)	843.00
3	970	161'–250'	120	8"	3½"	112.	30.	517.	350' 2100	2617	Add for 2" Pipe $22	1070.00
3	970	251'–430'	120	8"	3½"	194.	30.	857.	450' 2700	3557	Deduct for Machine	1384.00
											Trenching $80	
4	1290	56'–100'	220	8"	4"	50.	70.	450.	150' 900	1350	Add for 2" Pipe $17	486.00
4	1290	101'–170'	220	8"	4"	85.	70.	516.	250' 1500	2016	Friction Loss 2" Pipe 1# (10 GPM)	630.00
4	1290	171'–200'	220	8"	4"	100.	70.	635.	350' 2100	2735		833.00
4	1290	201'–320'	220	8"	4"	160.	70.	830.	450' 2700	3530	Deduct for Machine	1031.00
											Trenching $60.	
5	1660	60'–120'	220	8"	4½"	72.	70.	600.	150' 900	1500		
5	1660	120'–250'	220	8"	4½"	150.	70.	817.	300' 1800	2617		
6	1660	60'–120'	220	8"	4½"	72.	70.	600.	150' 900	1500		
6	1660	120'–250'	220	8"	4½"	150.	70.	817.	300' 1800	2617		
									450' 2700			
7	2070	50'– 90'	315	8"	5"	63.	120.	652.	150' 900	1552		
7	2070	91'–180'	315	8"	5"	126.	120.	841.	300' 1800	2641		
8	3010	30'– 35'	315	8"	6"	28.	120.	637.	150' 900	1537		
8	3010	36'– 85'	315	8"	6"	68.	120.	792.	300' 1800	2592		

* INCLUDES COST OF PUMPING UNIT, DROP PIPE AND PRESSURE TANK, CYLINDERS, ETC.

SHARE OF COST OF COMPLETE WATER SUPPLY TO EACH FARM PIPED FROM ONE WELL FOR DISTANCES UP TO ONE MILE

14	15	16	17	18	19
DATA	COST ½ MILE	DATA	COST 3/4 MILE	DATA	COST 1 MILE
Depth of Trench 4'	Based on	Depth of Trench 4'	Based on	Depth of Trench 4'	Based on
Dug by hand $.20 ft.	2" G. Pipe	Dug by hand $.20	3" G. Pipe	Dug by hand $.20 ft.	3" G.I. Pipe
Laying and Backfill .10 ft.	@ .20 ft.	Laying & Backfill .10 ft.	or "Transite"	Laying & Backfill .10 ft.	or "Transite"
Friction Loss 2# (5 gpm)	$1320.00	Friction Loss 1½# (10 GPM)	@ per ' .45	Friction Loss 2# (10 GPM)	@ per ' .45
Friction Loss 7# (10 GPM)		Friction Loss 3# (15 GPM)	$2970.00	Friction Loss 4# (15 GPM)	$3960.00
Friction Loss 15# (15 GPM)		Friction Loss 5# (20 GPM)		Friction Loss 7# (20 GPM)	
Deduct for 1½" Pipe $66	$273.00	Deduct for 2" Pipe $495	2098.00	Deduct for 2" Pipe $660	2593.00
Friction Loss 5# (5 GPM)	1437.00	Friction Loss 10# (10 GPM)	2262.00	Friction Loss 13# (10 GPM)	2757.00
Friction Loss 19# (10 GPM)	1610.00		2436.00		2931.00
Deduct for Machine	1793.00	Deduct for Machine	2618.00	Deduct for Machine	3133.00
Trenching $238	2295.00	Trenching $357	3080.00	Trenching $475	3615.00
Add for 2½" Pipe $88	866.00	Deduct for 2½" Pipe $198	1416.00	Deduct for 2½" Pipe $264	1746.00
	1087.00	Friction Loss 3½# (10 GPM)	1637.00	Friction Loss 5# (10 GPM)	1967.00
	1312.00		1862.00		2193.00
Deduct for Machine	1626.00	Deduct for Machine	2176.00	Deduct for Machine	2506.00
Trenching $159		Trenching $238		Trenching $317	
Add for 2½" Pipe $66	668.00	Deduct for 2½" Pipe $149	1080.00	Deduct for 2½" Pipe $198	1328.00
Friction Loss 2½# (10 GPM)	834.00	Friction Loss 8# (15 GPM)	1247.00	Friction Loss 10# (15 GPM)	1494.00
	1014.00		1427.00		1674.00
Deduct for Machine	1212.00	Deduct for Machine	1625.00	Deduct for Machine	1873.00
Trenching $119		Trenching $178		Trenching $238	
Add for 2½" Pipe $53	564.00	Deduct for 2½" Pipe $219	894.00		1092.00
Deduct Machine Trench $95	788.00	Deduct Machine Trench $143	1117.00	Deduct Machine Trench $190	1316.00
Friction Loss 5# (15 GPM)		Friction Loss 12# (20 GPM)		Friction Loss 16# (20 GPM)	
Add for 2½" Pipe		Deduct for 2½" Pipe $100	894.00	Deduct for Machine	1092.00
Deduct Machine Trench $80		Deduct Machine Trench $120	1117.00	Trenching $159	1316.00
			646.00		778.00
		Deduct Machine Trench $102	801.00	Deduct Machine Trench $136	943.00
			564.00		687.00
		Deduct Machine Trench $90	695.00	Deduct Machine Trench $119	819.00

served by a quarter of a mile of pipe line from one well, for wells of various capacities and depths.

For example, assume that a well has been brought in on a farmstead at a depth of 300', produces 25 gallons a minute, or 1500 gallons an hour with the water level between 250' and 300'. This quantity of water is sufficient to serve five farms. Column 1 shows the capacity of wells in terms of farms. Proceeding horizontally across the columns opposite 5 and corresponding with the well depth of 300', with water level 250' to 300', it is seen that $2617.00 is the cost of the well and pumping unit.

Further to the right opposite this figure in column 13 no figures are shown, as five farms cannot be included on a ¼ of a mile of pipe, but in column 15 is given $788.00 as the cost to each of five (5) farms deriving water from the same well, with a distribution system of ½ mile of pipe. Comparing this figure with the $1828.00 (second figure, Column 11), which represents the cost that each of the five farmers would have to pay if each had a separate well of the same characteristics, it reveals that a saving of $1040.00 is effected for each farmer. The corresponding figures in columns 17 and 19, involving 3/4 mile and one mile of pipe respectively, show considerable savings also.

As stated before, the costs of pipe lines are based on hand trenching. The data columns 12, 14, 16, and 18 show additional deductions possible by the use of trenching machines which could be provided on a non-profit basis.

In the example above, the $788.00 cost to each farmer in the system, could be reduced $95.00 by using a machine on the ½ mile line, $119.00 on the 3/4 mile, and $190.00for the distance of a mile. The tabulation shows that it is more economical to drill a new well on a farm than to run a mile of pipe to it from another farm.

In these same columns are also added other possible additions or reductions, due to changes in the size of the pipe to suit conditions, without increasing the friction loss beyond practical use.

As the figures in column 19 for two farms have exceeded the cost on an individual water supply, it is expected that the increase in pipe size necessary by extending the line to one and ¼ mile will likewise show no saving for three farms. Another extension to one and ½ miles probably will disclose the same condition. These figures or these added lengths were purposely avoided, as it is believed that sufficient figures as shown are satisfactory proof of the practicability of this method and all farms

can be served in the area by water systems composed of one to eight farms on a well.

To put this plan into practice, several small water users associations or cooperatives can be established over the area. The number of farms in one association would depend on the capacity of the well and the number of nearby farmsteads that could be served from that well. Preferably the well should be drilled near to a concentrated group of farmsteads and as near as possible to the road or other right of way. This will simplify segregating a small plot surrounding the well, to be owned jointly by the association. It will also avoid interference with farm field practice and be convenient to power lines.

One such small water users' association was organized on the FSA project at Bonners Ferry, Idaho, where one well served nine (9) contiguous farmsteads. A copy of the mutual agreement used is attached.

There is one other item of expense that will be involved to complete a water system, and that is the construction of a concrete pump pit about 8' x 10', and 7' deep, with about 6' below grade, and provided with a metal roof and vents. This is to protect the pumping equipment from weather damage and freezing in winter. It is placed directly over the well. The pressure tank can be buried in the ground close by. The cost of such a pit will be about $125 to $140.

FARM HOUSE DESIGN

In order to recommend the feasible means that could be adapted or created to minimize the financial commitments of needy settlers in providing suitable and essential housing for the area, design standards for farm houses that can be considered as suitable and essential will first have to be established.

The house, to be considered as suitable, must be designed (1) to serve as a farm house, (2) to accommodate various sizes of farm families, and (3) to provide conditions of reasonable convenience and comfort. In addition there are certain requirements that are essential to all low cost housing. The construction must be adapted to climatic conditions, and be well built. Sanitary measures should be incorporated to protect health. Finally, the cost should be as low as possible without sacrificing any of the above mentioned standards.

In an attempt to standardize these minimum requirements, the Engineering Office and the Home Management Section of the Farm Security Administration have used the following as adequate for farm housing.

Relation to the farmsteads. First, the area immediately surrounding the house is considered a part thereof and should be well drained, with sufficient land available nearby for the production of a subsistance food supply.

A potable water supply must be available. All wells should be covered, and houses should be so located that outdoor toilets, septic tanks, and other potential sources of contamination would obviate any possibility of polutian. All water-borne waste disposal should conform to sanitary requirements. Houses should be located on the farmstead so that any barnyard odors carried by prevailing winds, shall not be towards the house. The house should be oriented so that the barn and barnyard are within view of the kitchen, and to insure maximum sunshine for the daytime living quarters of the house. Consideration should also be given to the dust and noise of the public highway, especially when unsurfaced. The house should therefore be at least 50' from surfaced highways and at least 100' from dirt or gravel roads.

Space Requirements: Since farm houses go with the land, it is important that space be provided for present and probable family needs--one family may live there through the family cycle, or different sized families may acquire possession. The usual farm family must be considered as consisting of man and wife and children of both sexes. In addition it is not uncommon to find another member or relative living with the family.

Three bedrooms, one of which should be large enough to accommodate two double beds, therefore seem to be essential. This is also borne out by the experiences encountered by the FSA Tenant Purchase Program in remodelling houses. The principal request has been to provide a third bedroom, regardless of the size of the family. This is also true of the Longview Homesteads at Longview, Washington, where 60 four-room (two bedroom) houses were built in 1935.

In addition to creating a poor arrangement of rooms the expense of adding a third bedroom to a house originally designed for two is far greater than if the house had been built with three, or had been designed with a capacity for three bedrooms.

It was for these reasons that the FSA construction policy now requires that farm houses shall have not less than three bedroom capacity.

A house should provide space for living (living room), dining, and for kitchen, and at least have a capacity for three bedrooms. By this it is meant that although a family has no present need of three bedrooms, one or more can be added or finished inexpensively at a later date. How this can be accomplished will be discussed in detail under cost analysis.

Living, dining, and kitchen space may be provided in one room with some economy of total space, but the prevailing custom of farm families is to divide the space into two rooms, with dining space provided in either the living room or in the kitchen. The latter arrangement is more often preferred.

A comparison of minimum space required for each room as adopted by the Engineering office and the Home Management Section of the FSA, and those established by the Federal Housing Administration, is as follows:

LIVING SPACE	F. H. A.	F. S. A.
Living, dining, kitchen (when one room)	220 Sq. Ft.	300 Sq. Ft.
Living and Dining (when one room)	160 " "	210 " "
Kitchen and Dining (when one room)	130 " "	144 " "
Living (when one room)	140 " "	150 " "
Kitchen (one room)	60 " "	84 " "
Dining (one room or space)	70 " "	60 " "

SLEEPING	F. H. A.	F. S. A.
Major Bedroom	100 Sq. Ft.	125 Sq. Ft. (for 2 double beds)
Additional Bedrooms	70 " "	70 " " (Sufficient to accommodate a bed, dble.)

Bath (Required space about 5x7)	To accommodate tub, lavatory, toilet.	To accommodate tub, lav., toilet.

STORAGE SPACE	F. H. A.	F. S. A.
Closets (each bedroom)	no size stated	3' x 24''
Closets (general storage)	30 Sq. Ft.	3' x 24''
Linen Closet		2' x 22''
Cleaning Closet (in kitchen)		3''x 18''
Kitchen Storage - Dishes and utensils (including sink space)		2' x 8'6"
Food Storage (when there is no basement) (ventilated and insulated)		24 Sq. Ft. Min. to 36 " " preferred
Utility Room or Work Porch		about 50 " "

It will be noted that the minimum space requirements for living, also sleeping, and cooking adhered to by FSA are larger than the standards set by F. H. A. For this, the reasons are that farm families require more space than city families. More living functions are performed on the farm, such as preserving and storing large quantities of food. There is no corner store handy as in a city. Outside help at harvest time requires a larger

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LIVING SPACE	F. H. A.	F. S. A.
Living, dining, kitchen (when one room)	220 Sq. Ft.	200 Sq. Ft.
Living and Dining (when one room)	160 " "	210 " "
Kitchen and Dining (when one room)	130 " "	144 " "
Living (when one room)	140 " "	130 " "
Kitchen (one room)	60 " "	84 " "
Dining (one room or space)	70 " "	60 " "

SLEEPING	F. H. A.	F. S. A.
Major Bedroom	120 Sq. Ft.	125 Sq. Ft. (for 2 double beds)
Additional Bedrooms	70 " "	70 " "

(Sufficient to accommodate a bed, table.)

Bath	(Required space about 5x7)	To accommodate tub, lavatory, toilet. tub, lav., toilet.

STORAGE SPACE	F. H. A.	F. S. A.
Closets (each bedroom)		no size stated 3' x 2½"
Closets (general storage)	30 Sq. Ft.	3' x 2½"
Linen Closet		2' x 2½"
Cleaning Closet (in kitchen)		3'x 1½"
Kitchen Storage - Dishes and utensils (including sink space)		2' x 8'6"
Food Storage (when there is no basement) (ventilated and insulated)	24 Sq. Ft.	Min. to 36 " " preferred about 50 " "
Utility Room or Work Porch		

It will be noted that the minimum space requirements for living, sleeping, and cooking adopted by FSA are larger than the standards set by F. H. A. For this, the reasons are that farm families require more space than city families. More living functions are performed on the farm, such as preserving and storing large quantities of food. There is no corner store handy as in a city. Outside help at harvest time requires a larger

dining space. All laundering must be done, milk prepared for market, and the milk separating apparatus kept clean.

The work porch or utility room is therefore deemed necessary to provide space for washing machine, tubs, milk separator, and a place where muddy boots, and wet coats can be taken off and stored. By increasing its size, cellar stairs or canned goods may be housed.

This extra equipment and surplus food needs storage space. A basement provides facilities for food storage, but when no basement exists, space for this purpose must be added to the first floor plan.

The usual convenient ceiling height of the first floor, from finished floor to ceiling, is 8' 4". This allows the use of 8' studs with sill and double plate. However, when wallboard or plywood are to be used as wall finish, the height should be reduced to 8', because this kind of material comes in 8' lengths. The sill and plate are thus used as nailing surfaces at the floor and ceiling. Otherwise nailing strips will have to be provided at extra cost.

Arrangement of rooms and facilities. Desirable arrangements from the standpoint of efficient and satisfactory operation of the normal household activities are:

A. Kitchen
   1. The main kitchen work area should not be broken by much used traffic lanes.
   2. Storage should include a sink unit of 8'6" x 24".
   3. Arrangement of equipment and space between should conform to established standards to promote efficient operation.
   4. Kitchen area should have cross ventilation.
   5. Kitchen area should have a sink and proper disposal of waste water.

B. Bathroom
   1. Should be reasonably accessible from the back entrance of the house.
   2. Should be located so as to be easily heated from stoves located in living room and kitchen.

C. Bedrooms
   1. Major bedroom should be large enough for a double bed and a crib.
   2. Second bedroom should be large enough for two double beds.
   3. Third bedroom should be large enough for one double bed.
   4. All bedrooms should have closets of not less then 3' x 24".

5. Wall space should be adequate to accommodate a chest of drawers.

D. Health and Safety Provisions.

1. All entrances should be protected from the rain.
2. The most used entrance should be off the utility room.
3. Play ground for younger children should be so located that the homemaker can see it from a kitchen window, and it should be fenced to afford children protection from the farm stock and to prevent them from wondering to the highway.
4. Entrances should, where possible, be located so as not to face the direction from which wind driven rains come.
5. All openings should be screened, the windows at least half.

The providing of these necessary facilities plus the following requirements for insuring privacy, influence the farm house design. It is recommended that entrance to a bedroom, bathroom or toilet compartment shall be provided with a door, that a bathroom opening into a kitchen will not be acceptable, and that the sole access to a habitable room shall be, not through a bedroom. All exterior openings shall be provided with screens.

To give a more comprehensive idea of how these requirements influence the design of a farm house, a series of diagramatic sketches are added hereto, to show the step by step development of a farmhouse, beginning with the simplest arrangement of the approximate minimum spaces for living, dining and cooking, put together to form a house. The spaces or rooms are placed in a rectangle, as added angles or corners complicate roof design and added expense is incurred.

In order to keep cost as low as possible, the designs are based on one chimney only, to serve both kitchen stove and living room heater. The house is considered as having no basement.

The governing factors controlling all designs are: One chimney, concentrated plumbing, convenient room arrangement, and the objective of creating a design to which rooms can be added by the least amount of alteration and cost. Without these limitations the possibilities of design and range of costs are considerably expanded beyond the scope of low cost housing.

Other added advantages of having the bathroom adjacent to the kitchen are: The opportunity of installing the hot water tank (which is usually connected to the kitchen stove) in the bathroom to warm the room, and making the use of the bathroom easily accessable to the back door entrance without it being necessary to pass through any of the living quarters of the house.

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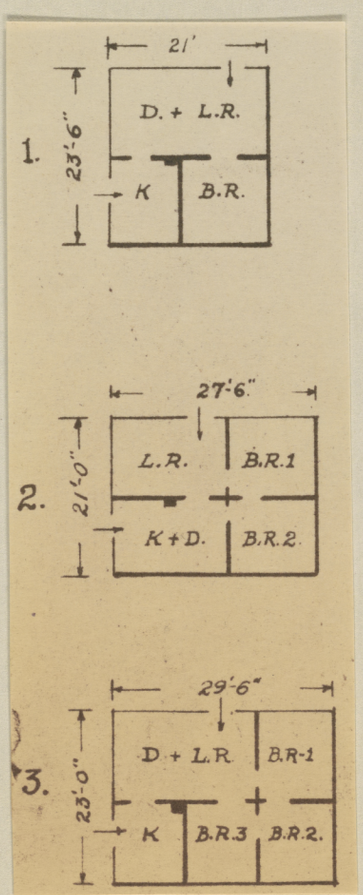
The following detailed explanation will be confined only to those diagrams which include sleeping space or bedrooms. The notes accompanying each sketch are self explanatory. It should be particularly noted how the number of doors increases in proportion to floor area; that is, if all closets are provided with doors. The cost of this accessory and the windows is a large item of expense, and is one reason for the increase in the unit cost per square foot of house construction.

First Stage: Simple arrangement of the minimum living, dining, kitchen, and bedroom spaces. Note the additional area that must be allowed for partitions and walls, to enclose the minimum spaces.

L.R. - Living room, B. R. - Bedroom, D. - Dining Space, X - Chimney. (Solid arrows indicate circulation; dotted arrows indicate alternate access to rooms)



THREE ROOMS

Combined living & Dining room,
Kitchen, one Bedroom
4 doors
Window area 10% of floor space- 43 sq. ft.
Floor area - 422 sq. ft.
Used by walls & partitions - 61
Total area 483 sq. ft.

FOUR ROOMS

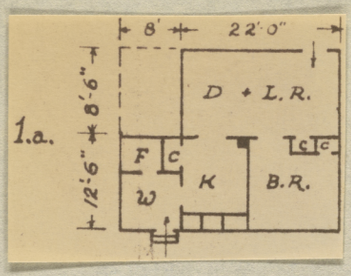
Living room, combined kitchen & dining,
2 bedrooms
5 doors
Window area 10% of floor space - 50 sq. ft.
Floor area -505 sq. ft.
Used by walls & partitions -73
Total area 578 sq. ft.

FIVE ROOMS

Combined living & dining, kitchen,
3 bedrooms (1 B.R. can only be entered thru one of other two B. Rs.)
6 doors
Window area 10% of floor space - 60 sq. ft.
Floor area 596 sq. ft.
Used by walls & partitions 83
Total area 679 sq. ft.

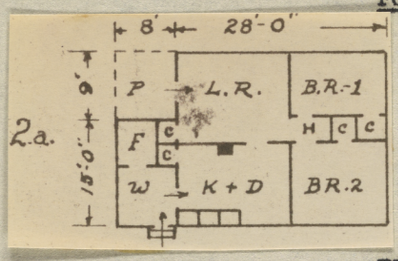
Second Stage: It should be noted that the partitions shown in stage 1 are simply for privacy. In order to incorporate into these designs the storage space required for convenience of practising good housekeeping, additional floor space will have to be provided. The following diagrams will show that changes in design must be made, and the area increased, in order to provide the extra storage space. Closet space will be confined to design limitations rather than minimum dimensions. No. 3 will also have to be corrected so that bedroom 2 can be entered without passing through either bedrooms 1 or 3. In this series of diagrams will be shown the change in design caused by adding: the clothes closets for each bedroom, the work

porch, canned goods storage, and kitchen storage space. Symmetry of room areas has been retained, and minimum cost has been constantly sought.



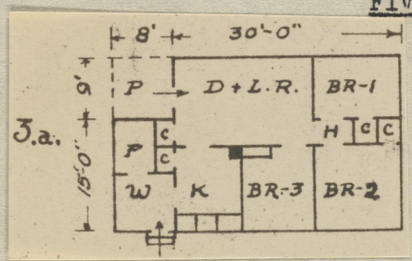
THREE ROOMS:

Diagram 1 with storage space added
9 doors
Window area 10% of floor space - 54 sq. ft.
Floor area -539 sq. ft.
Used by Walls & partitions 89
Total area 628 sq. ft.



FOUR ROOMS:

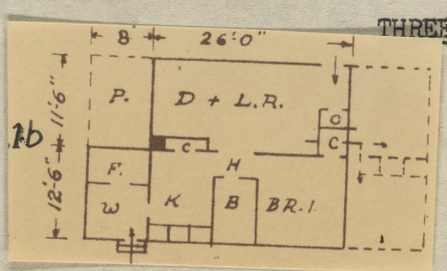
Diagram 2 with storage space added
11 doors
Window area 10% of floor space - 66 sq. ft.
Floor area -654 sq. ft.
Used by walls & partitions-110
Total area 764 sq. ft.



FIVE ROOMS:

Diagram 3 with storage space added
12 doors
Window area 10% of floor space - 73 sq. ft.
Floor area -724 sq. ft.
Used by walls & partitions-116
Total area 840 sq. ft.

Third Stage: The diagrams of the second stage expanded to include a bathroom area. N ote the increase in hall space required to provide convenient access to rooms. In diagram 3b the bathroom is placed between two bedrooms instead of adjacent to kitchen. This location is more convenient to all rooms, at all times, and is a common arrangement in houses with three bedrooms on the first floor.



THREE ROOMS:

Diagram 1a with bathroom space added
10 doors
Window area 10% of floor space - 62 sq. ft.
Floor area -619 sq. ft.
Used by Walls & partitions-105
Total area 724 sq. ft.

FOUR ROOMS:

Diagram 2a with bathroom space added
12 doors
Window area 10% of floor space - 72 sq. ft.
Floor area -720 sq. ft.
Used by Walls & partitions-120
Total area 840 sq. ft.

FIVE ROOMS:

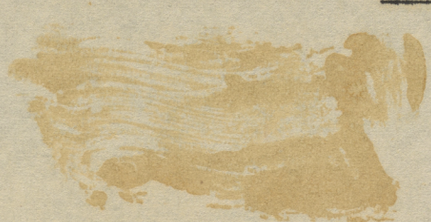


Diagram 3a with bathroom space added
13 doors
Windows area 10% of floor space - 81 sq. ft.
Floor area -804 sq. ft.
Used by walls & partitions -132
Total area 936 sq. ft.

The dotted lines indicate two rooms can be added by extending the foundation and roof, and then by simply removing the partitions (which

could be temporary construction if the extension is expected to be made in the near future) and adding the doorway in the outside wall. Thus, houses with one and two bedrooms on the first floor can be economically enlarged without destroying the arrangement of rooms.

Fourth Stage: This stage is added to demonstrate not only the additional space required to provide stairways, but to show that their location in the house plan is of utmost importance. A stairway located properly, makes more usable floor space possible, at less cost per square foot; as will be shown in a cost analysis of these diagrams to follow later in this report.

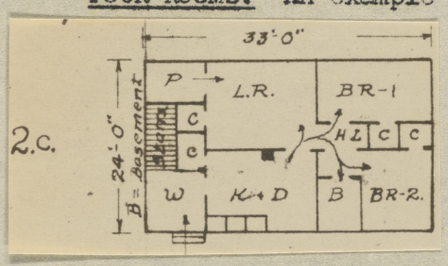
There are two reasons for stairways in a house; one is for access to the basement, and the other is for access to the second floor. When both stairways are to be incorporated into a plan, it is cheaper and more conserving of space to place both stairs in the same stair well, i.e. one over the other. It is also imperative that the stairs leading to the second floor be placed so that no dormers are necessary for "head room", nor for light for the upstairs rooms. To avoid the necessity of dormers the stairway on the second floor must open on the floor area over which the pitch of the roof rafters allows full height doors. This space is usually roughly confined to that part of the floor area that does not extend more than four to five feet on each side of the roof axis or ridge and parallel thereto. It should be added however, that this is ordinarily true only in story and a half houses, where the width of the house is from 24 to 28 feet wide and the roof pitch is 10 inches vertical to 12 inches of the corresponding width. This is a steeper pitch than ordinarily used on one story houses in this climate.

Diagram 2c below is an example of how a stairway can be added to diagrams 1a, 2a, 3a, 1b, 2b, 3b, for access to the basement through the work porch area. Of course there is the alternative of installing an "outside" stairway, but in rural areas the drainage of the basement is difficult, and therefore in regions where it is usual to have snow, the stairway should be covered, either by a "cellar door" or by the main roof as indicated in the following examples. If convenience is a consideration the "inside" stairway is the choice. The difference in area between house 2b and 2c is only about 52 sq.ft. which also provides space for a front porch or vestibule. In this case too, the work proch entrance should be opposite the entrance to the kitchen instead of as shown, so that one passage area serves all doors and therefore enlarges usable work porch storage space.

A stairway located on one end of a house (as in 2c) is adaptable to single story construction only for the following reasons: (1) to place a

stairway leading off of the space "p" which can be vestibule, to the second story over the basement stairway would necessitate a dormer for headroom, because the second floor stair opening opens off the second floor area where the distance from floor to roof rafters is less than door height. (2) However, there is a possibility of having the opening on the favorable area, by installing a turn in both the basement and the second floor stairways. This arrangement, however, would eliminate the closet off the kitchen which space would become the first flight of the basement stairs, leading from the kitchen; and since the upstairs opening is at one end of the living space, the space can only be one room, because a division into two rooms would require passing through one to gain access to the other.

FOUR ROOMS: An example to demonstrate how an "inside" basement stairway can be added to diagrams 1a, 2a, 3a, 1b, 2b, 3b,



2.c.

12 doors
Window area 10% of floor space - 76 sq.ft.
Floor area -756 sq. ft.
Used by walls & partitions-156
Total area 912 sq. ft.

To overcome this unsatisfactory feature, story and a half houses are designed with stairways centrally located, such as shown in diagrams 1x and 2x to follow. In both of these diagrams the entrance to the basement stairway is convenient from the kitchen and the stairs open on the favorable area of the second floor between two bedrooms, thus providing independent access to both rooms. Each bedroom has window space on the gable end wall.

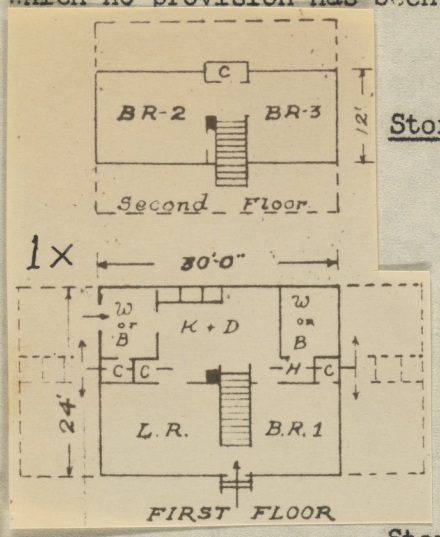
The dotted lines in the first floor plans indicate possible expansion of this floor to provide additional bedrooms. The chief advantages of these two plans is that they can be adapted to single story construction with possible lateral expansion and/or they can beused as story and a half houses with additional bedroom space available. In case rooms are added to the first floor and bedrooms are also planned upstairs, the first floor addition would have to be designed with a flat roof. The only difference in the design between the one story and story and a half types is in the pitch of the roof. In the one story type the pitch would be about 7" to 12", whereas in the story and a half type the pitch would be 10" to 12".

An added advantage of diagram 1x is that the space adjacent to each end of kitchen and dining space can be used either as a work porch or bathroom, depending on which end of the house the future addition is contemplated. Bedroom No. 1, can also be used as a dining room, no matter whether the extra bedrooms are added to the first floor or upstairs.

In one story types, the stairways can be used for access to the basement; or when no basement is desired the stairway space can be utilized as

closet space for the kitchen, living room, and bedroom.

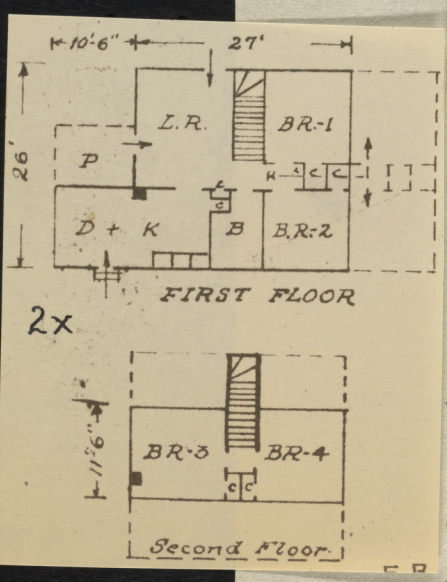
Any one or all of the extensions can be made without destroying the desirable arrangement of rooms and without alteration to the original rooms. These advantages can best be understood by examining the accompanying house plans, and comparing the plans for this type of design with the others in which no provision has been made for expansion.



Story and a half House (Expandable Type)

13 doors
Window Area, 10% of floor space - 85 sq. ft.
Floor Area, 1st floor 590 sq. ft.
" " 2nd " 260 " "
Used by walls and partitions 200 " "

Total area 1050 " "



Story and a half House (Expandable Type)

13 doors
Window Area, 10% of floor space - 92 sq. ft.
Floor Area, 1st floor 664 sq. ft.
" " 2nd " 260 " "
Used by walls & partitions 228 " "

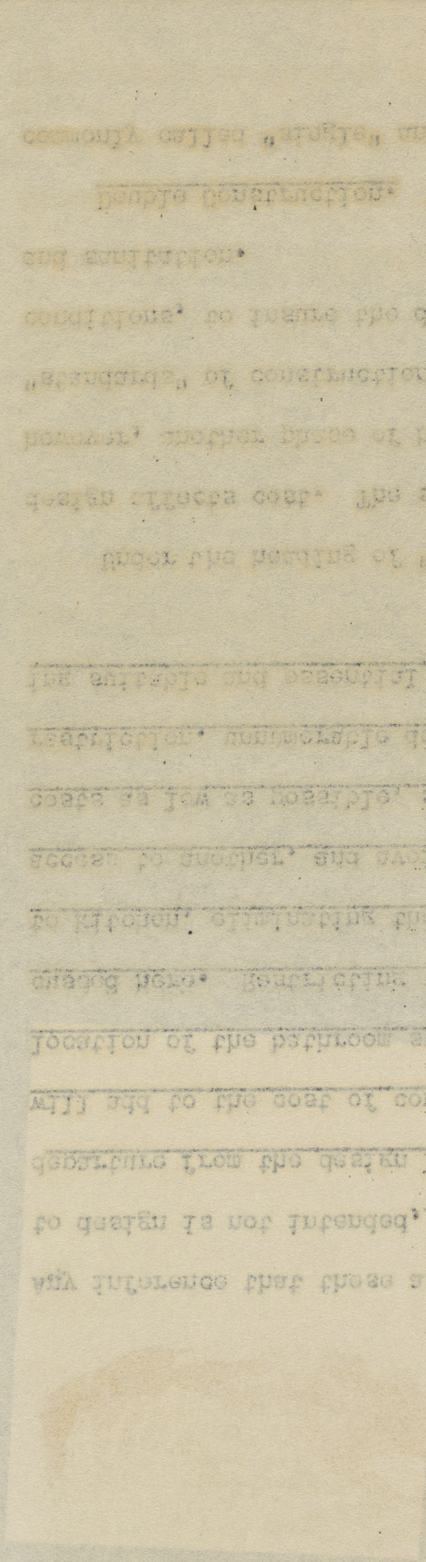
Total area 1152 " "

Any inference that these are the only farm house types that it is possible to design is not intended, but it is nevertheless true that any radical departure from the design limitations upon which the diagrams were based, will add to the cost of construction. It should also be noted that proper location of the bathroom space makes imperative a design of the kind discussed here. Restricting the designs to one chimney, with bathroom adjacent to kitchen, eliminating the necessity of passing through one room to gain access to another, and avoiding the use of roof dormers in order to keep costs as low as possible, standardizes interior arrangement. Waiving these restriction, unnumerable designs are possible, but the objective of providing suitable and essential housing at minimum cost must be abandoned.

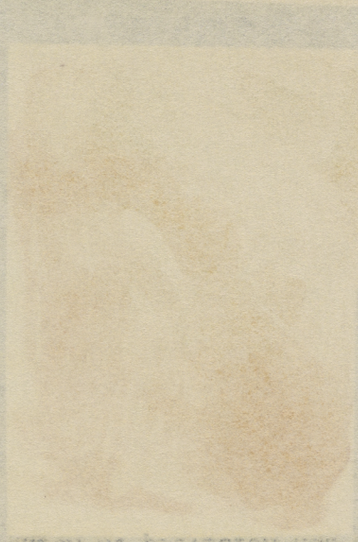
FARM HOUSE CONSTRUCTION

Under the heading of "Farm House Design" it has been demonstrated how design affects cost. The simpler the design, the lower the cost. There is however, another phase of housing that affects costs, and that is the "standards" of construction. These standards are established to suit climatic conditions, to insure the durability of the structure, and provide safety and sanitation.

Double Construction. There are two general types of construction, commonly called "single" and "double" construction. The term "single"



(Expensive Type)



(Inexpensive Type)

construction refers to frame structures, in which the floors and the outside of exterior walls are constructed of a single layer of boards. The term "double" construction designates that floors and the outside of exterior walls are built using two layers of boards, usually with building paper sandwiched between.

The suitability of either type depends mainly on the climatic conditions during the winter months of the region in which the houses are built. In the Southern states as far north as Missouri and also at certain places along the West coast where mild winter weather prevails, the "single" type of construction is generally used. In regions where the climate is continental in character, or the temperature for the months of November, December, January and February is often below freezing, the common practice is to use the "double" construction. The reason is that houses of double construction are warmer and therefor more economical to heat than houses of single construction.

Data contained in Section 2, "Climatic Summary of Eastern Washington", a publication of the Weather Bureau, shows that the average temperature for the winter months of this region is about 32° and the average minimum temperature is about 25°. However temperatures during the winter months drop to as low as 30° below zero, and during the summer months may rise to 112° or 118°. About 70% of the annual precipitation occurs during the four winter months, with about 12 to 18 inches in the form of snow. Total average precipitation varies from 6 to 10 inches per year for most parts of the area.

Since the region is devoid of woodlands, as a source of fuel supply, coal is commonly used by its inhabitants. In order, therefor, to minimize the cost of heating, double construction is recommended. This feature has been included by FSA in all construction projects in the Northern States, with weather conditions similar to Columbia Basin.

In addition to being essential for reduction of fuel costs, double type of construction adds to the durability of the structure. Since undoubtedly the financing for the construction of improvements will be made on a basis of a 25 to 40 year amortization, the farm structures should be built to last these longer periods.

Foundations. The first item of importance influencing durability is the foundation. There are two types of foundations, the pier type and the solid wall type. The difference between the two is that instead of a continuous concrete wall six inches thick in the solid wall type, concrete piers are used at intervals which are spanned by a heavy sill. This latter type requires a skirting strip between piers to close the open space between

piers from the sill to the ground in order to enclose the space beneath the floor. The cost for both types is about the same; in fact some contractors have installed the solid wall type in lieu of the piers at no extra cost.

Because the solid wall type is no more expensive, and because it provides a more complete enclosure of the air space beneath the floor, and eliminates the unsightly mud splash on the painted skirting strip, the FSA has specified the solid wall type in regions where winters are cold and snow is common. Another advantage of the wall type is that it allows the farmer to install a dug-out basement. The depth of a 6" foundation wall in the ground should be at least 18 inches; and if lath and plaster interior wall finish is specified, the depth should be increased to the depth of frost penetration. This is to prevent frost from heaving the wall and cracking the plaster. The height of the wall above the ground should be about 14 inches, so that there is space between the floor joist and and the ground of about 16 inches, sufficient for access to plumbing in case repairs are needed. This adds up to a total minimum wall height of three feet. However, according to statistics of the Weather Bureau, the average frost penetration in the project area is 2', therefor the wall height for lath and plastered houses should be increased to 3feet 6inches, with 24 inches below grade.

Framing. The framing of the structure is the next item of importance. To insure reasonable stability, permanence and safety, all floor joists should be at least 2" x 8" spaced sixteen inches center to center and braced between with solid blocking at bearings and with "herring bone" bracing between bearings.

The floor joist under all partitions should be doubled. The minimum practical spacing of the 2" x 4"s used as wall studding, ceiling joist, and roof rafters is two feet on centers. This spacing for wall studs and ceiling joist is sufficient for plywood, but when ceilings are to be sealed with insulation board or lath and plaster, the spacing of the ceiling joist should be reduced to 16 inches. At 24 inch spacing there is a tendency of the insulation board to sag between joists. Wall studs should be doubled at all openings, and should provide a bearing for the trimmers at the top and/or bottom of the openings. All walls and partitions should have a single 2" x 4" plate.

The quality of the lumber should be such that it is free of knots which would impair its strength, be true to dimensions and well seasoned.

These qualities are practically a description of No. 1 grade, dimension lumber. This grade or its equal is required in FSA specifications.

The frequent characteristics of so called "cheap houses" are: 2" x 8"s floor joist spaced 2 feet on center, single joist supporting partitions, no solid or herring bone bracing, single studs at openings and an inferior grade of lumber. To save perhaps $200 or $300, an investment of $2500 or more is jeopardized.

Roof. Although the FSA has used shingled gabled roofs on farmhouses throughout the Northwest, an explanation will be added here, why this type is being used in preference to flat or "shed" roofs. The roof area of gable roofs is about 17 to 20 percent greater than flat roofs on single story houses, and about 25 percent greater on story and a half houses.

This suggests that flat roofs are cheaper to construct than gable roofs. There would be a saving of about $20.00 in roofing material and about $18.00 in framing the roof of a one story three bedroom house, provided the roof framing lumber was of the same dimensions, and ceilings were used in both types. However, to insure comfort during the hot summer months, the flat roof must be insulated by means other than that provided by the air space between the roof and the ceiling. Heavier rafters are also necessary especially where the roof may have snow coverage. Flat roofs are subject to more leaks than gable roofs and therefore cost more to maintain. This Northwest country is the home of shingles, which have always been considered one of the best roofing materials. Shingles, however, can not be used as a covering for flat roofs; in fact can not be used successfully on roofs with less than about a third pitch or four or five inch rise in twelve inches. Shingles are permeable and therefore their function is to shed water. The air space under a gable roof is valuable as an insulator and as storage space.

The advantages of a gable roof in its practicability and in its appearance on small houses therefore warrant its use. Shingles are available in different grades called Certigrade No. 1, No. 2, and No. 3. As an example of the difference in cost of these grades for covering a "square" or 100 sq. ft., prices quoted at Ontario, Oregon, during the winter of 1940-41 were $4.50 for No. 1, $3.25 for No. 2, and $3,25 for No. 3. On an average size house using 12 squares, the difference in cost between No. 1 and No. 2 is about $9.00. It costs no less, and frequently costs more to apply second grade building material than it does first grade. For this reason, plus the assurance of a better roof of longer life, it is recommended that only

No. 1 shingles be used on houses and the No. 2's be used on barns and outbuildings.

Enclosing and Finishing. Now that a substantial frame has been erected on a good foundation and protected with a well built roof, the remaining part of the structure is a matter of enclosing the outside walls, applying the interior wall finish, installing doors, windows, screens, chimney, wiring, trim, and painting.

The outside of exterior walls is first covered with sheathing, usually shiplap nailed on diagonally, to better brace the frame, and so that longitudinal jointing of the sheathing does not coincide with the jointing of the siding. If there is not too great a difference in cost, 3/4" insulation board impregnated with asphalt is used for sheathing in place of the shiplap. Although the insulation board costs more, the labor to apply it costs less, which often about balances the cost of furnishing and applying the shiplap. No paper is used between sheathing and siding when the insulation board is used. The advantage of the insulation board is a more air tight job and a warmer house.

In order to economize as much as possible without sacrificing structural stability and appearance, medium quality lumber has proven satisfactory for wall sheathing, sub-flooring, roof sheathing, siding, interior and exterior trim, and finished flooring.

The species of lumber used depends upon the cost delivered at the buildingsite and the purpose for which it is to be used. The grade designation of the lumber depends upon the species; that is, the grading of Ponderosa Pine, Fir, Larch and Englemann Spruce produced under rules of the Western Pine Association is different from that established for West Coast Cedar, West Coast Hemlock, and West Coast Fir, under rules of the West Coast Lumberman's Association.

As an example, suppose that all of these species were obtainable for about the same price. The choice of drop siding of medium quality would be "C" West Coast Fir, "C" West Coast Hemlock, "D" fir or larch, No. 2 Ponderosa Pine or Englemann Spruce. To enable a better understanding of lumber grades, species and their uses there is attached a "Guide to Purchasing Lumber for General Building Purposes in Montana" which shows comparative qualities and grade designation of the principal west coast indigenous species. When cost is not a factor, siding is usually fir, or pine, as these species take paint more satisfactorily.

Flooring. Hardwoods, such as oak or maple, are too expensive to be

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Flooring. Hardwoods, such as oak or maple, are too expensive to be

used as finished flooring, as are the better grades of the softwoods, such as fir or larch. These are available either with the grain flat or vertical. The vertical grain wears better, and is less apt to splinter. As most of the floor area is covered by rugs or linoleum, the "C" grade of V.G. Fir or "D" grade of V.G. Larch serve the purpose of providing a tight flooring easy to clean. The difference between the better grade and the last mentioned is only a matter of appearance. The better grade is clear and the latter contains small pitch pockets. To save cost and still provide a serviceable floor "C" V.G. Fir or "D" V.G. Larch are most frequently specified by FSA.

Doors, Windows, Screens. On the other hand, No. 1 doors and windows are specified in lieu of lesser grades. No. 1. grade is free of blemishes or pitch pockets which are difficult to disguise with varnish or paint because of the "bleeding" characteristic. To save the cost of an extra door the entrance to the work porch is provided with a combination screen and storm door. The screened panel is removed in the winter and replaced with a glass panel. All windows are provided with at least half screens.

Double hung sash are used in all windows except on the work porch, where single sash that can be removed are most practical. A saving of $30.00 to $40.00 per house can be accomplished by using friction window regulaters instead of pulleys and weights.

Interior Wall Finish. The last important item is interior wall finish. Lath and plaster is preferred by most people, and therefore always specified as an alternate to ascertain the cost of it compared with other types such as plywood or pine boards.

Insulation board for side wall finish has proven unsatisfactory. It does not wear well under the severe usage it generally receives in a farm house, and has a tendency to scuff off.

At this writing, ¼" plywood has advanced considerably in price. At the Bonners Ferry Project in Northern Idaho, bids on 37 houses in 1939 were $100.00 higher per house for lath and plaster finish than for plywood. A trial invitation for bids at Ontario, Oregon, in February, 1941, showed no difference in the two alternatives. It would not be surprising therefore, to receive bids at this time (May, 1941) with lath and plaster finish the cheaper, as ¼" plywood is now about 7cents per foot, when in 1939 it was 3½ cents.

Proper insulation of at least the ceilings (the area of greatest heat loss) is an added expense that may be justified. However the cost of mater-

ial and labor for the simplest kind of a modern house is so out of proportion to a farmer's income, that it is necessary to economize wherever possible on items that can be considered nonessential. The F. S. A. in this region has specified that ½" insulation board be installed on ceilings, regardless of the side wall finish, as the insulating value of insulation board is greater than plywood or lath and plaster. Thus some insulation is provided with no increase in cost.

It should be mentioned here again that in order to economize on construction costs, the height of the room (from finished floor to ceiling) conveniently established by the use of 8 ft. studs placed on a 2" x 4" sill and topped by a double 2" x 4" plate, at 8' 4", should be reduced to 8feet, so that interior finishing sheet material of standard 8feet lengths can be nailed to the sill piece at the floor and to the plate at the ceiling and thereby eliminate the extra cost of providing nailing strips.

Interior trim is kept at a minimum, as shown on Sheet A4 of the accompanying plans of house 2 X.

Finishing. To preserve window frames and sash, and also to protect interior wall finish from the weather, galvanized metal flashing should be provided on the top of all exterior openings that are not protected by the overhang of the eaves.

Chimney. A full length brick chimney (from the ground up) is provided in all houses. There is practically no economy in constructing a chimney on a wall bracket, because the cost of strengthening the floor to support the chimney about equals the cost of the extra length of the chimney from the bracket to the ground. To reduce the risk of a fire on a farm, chimneys should be provided with a terra cotta flue lining. However, this item almost doubles the cost of a chimney, as the lining costs about $1.00 per ft. Therefore for economy only, chimneys are specified to be built with a plastered flue. If the plastering is carefully done, the chimney can be as safe as a lined one.

Electric Wiring. It has been the policy of the FSA to wire all farm houses whether electric power is available or not. Electric fixtures are included only when power is available. One ceiling outlet, operated by a wall switch is specified for each living and dining space, kitchen, hall, bedroom, and front porch. Extra ceiling outlets, operated by pull cord, are provided over the kitchen sink and on the work porch. One double convenience outlet is specified for the work porch, kitchen, dining and each bedroom, and two for the living room.

In story and a half houses, two-way switches are installed to operate the hall lights from either floor. A specified cost limit is placed on the fixtures. Future wiring to the outbuildings is provided for from the house circuit.

All wiring is done according to the National Electric Code, and only equipment approved by the National Board of Underwriters is used.

Plumbing. Complete plumbing of a farmhouse includes: piping cold water from outside the foundation (a distance of 4 or 5 feet) to the kitchen sink, bathroom fixtures, hot water heater, and to one outside sill cock; connecting hot water pipes to heater, tank, kitchen sink, and bathroom fixtures; installing drain pipes from all fixtures, properly vented and connected to a grease trap and steel septic tank of 300 gallon capacity (sufficient for ten people) by 4" sewer pipe and complete with at least 150' of 4" tile laid in graveled trench, for the disposal of waste.

All water piping of fixtures in the house circuit is of ½" galvanized steel, supplied by a 3/4" "lean-in". Drain pipe stacks are cast iron.

The kitchen sink is a 20" x 30" white enamel cast iron flat rim type with separate faucets for hat and cold water.

The hot water range tank is 30 gallon capacity, galvanized copper-steel standard weight type, made to withstand 85 lbs. of pressure.

The most economical bathroom fixtures are the three-piece outfits featured by Sears, Roebuck and Montgomery-Ward Companies. The cheapest outfits are with the leg type tub, and cost, at this writing, about $50.00. The cheapest set with "built in" type tub is about $90.00. These are complete with faucets, and traps. It has been necessary to specify the leg-tub outfits in all FSA Contracts.

Painting. The exteriors of new houses are painted three coats of a good grade of lead and oil paint. In order to decorate the interior as practically and as cheaply as possible, the interior painting is done as follows: two coats varnish on doors and trim; two coats paint with a third coat of a mixture of paint and enamel or varnish, proportioned one quart of enamel or varnish to one gallon of paint for the kitchen and bathroom, in order to provide a washable, stain proof surface. Plaster walls are given one coat of casein or waterproof cold water paint, plywood walls are given one coat of boiled linseed oil or two coats of casein waterproof paint. This oil finish on the plywood gives a natural wood finish to the walls and provides a base for an oil paint finish at a later time. If tinted walls are preferred, it takes two coats of casein paint to cover.

Two or three coat oil painting of the walls is too expenseive, and is an item that the owner can do at a later date.

All insulation board ceilings should be at least oil sized, and in addition the kitchen ceilings should be oil painted.

The most economical and satisfactory finish for the floor after sanding, is two coats of floor seal similar to "SEAL-O-SAN" or "Endwood". This is generally used on gymnasium floors and can be applied easily and quickly with a lambs wool mop, or spread on with a rubber squeegee. It dries quickly and leaves a protective surface on the natural wood that can be waxed. It is more serviceable, more economical, and has a better appearance than a stain-varnish or shellac-varnish finished floor.

Hardware. Medium quality of hardware is specified throughout.

COSTS OF CONSTRUCTION:

There has been some discussion of the possibility of adopting the adobe or sun-dried brick type of construction on this project, with the belief that with this natural material, a settler can build his own home at great saving. In order to give as much information as possible on this subject, an appendix section in adobe construction has been added, to supplement the following discussion.

The building costs of houses of both types are dependent on labor and material costs, and the design, size, and specifications of the building. All are variable quantities which makes it difficult to estimate the costs of constructing houses a year or two in advance of the time they are likely to be built. Cost of labor varies according to the prevailing wages in the territory in which the houses are to be built, and upon whether non-union or union labor is used. The cost of material of the same grade and quality varies for different regions, depending on freight rates and on market fluctuation.

For example the cost of all five room houses is not the same. There may be a greater proportion of partitions and/or waste, closet and hall space, in one than there is in another. The size of the rooms may be different, which of course affects the size of the house. The quality and kind of material, the construction requirements, and the amount of ornamentation used, are all determining factors of cost.

The cost therefore of each type of five room house must be based on the design, and size shown by the plan, and the construction requirements, plus the kind and quality of materials stipulated in the specification.

The purpose of plans and specifications is not only to domonstrate to someone else the kind of a house to be built, but also to provide a uniform basis for cost estimates, when bids are invited for construction. It would be expected that the more specific the specifications, the more uniform will be the prices received for the same house. Theoretically this is true, but even so, the method of estimating, the experience and the business principles of the bidder cause wide variations in prices of various bidders.

There is a way, however, of determining the cost of construction with some degree of accuracy, and that is by comparing the estimated costs of houses of a given type, with the average bidders prices, and then analyzing the break-down of items into labor and materials. It is in this way that the Engineering Section of the Farm Security Administration of Region XI has established reasonable unit prices for the different phases of construction, that can be used for estimating purposes.

From an analysis of bids received from contractors on a number of house types in different parts of the states of Oregon, Washington and Idaho, over the past four years, it has been possible to estimate the cost of construction, (1) Of a single house built by contract in the Tenant Purchase Program: or (2) Of groups of ten to forty houses built in a concentrated area by one contractor.

To arrive at a fairly accurate estimate of a basic minimum cost of construction, without going into a detailed explanation of the above mentioned analysis, there is attached hereto a tabulation of the cost of constructing one each of the several houses represented by the diagramatic plans introduced previously in this report under "Farm House Design", based on the specifications already set forth under "Farm House Construction", and using an average rural wage scale of $.75 per hour and the market value of material in the project area at this writing, March, 1941. This labor average is derived from a computation of labor costs proportioned as follows: 25 percent at $1.25 per hour (electricians, plumbers, masons, plasterers, and an expert carpenter), 25 percent at $.75 per hour (carpenters helpers, painters) and 50 percent at $.50 per hour (common laborer). The tabulation also shows the total area in square of feet of the floor plan, divided into usable floor space, and that part occupied by walls and partitions.

In addition to the cost of labor and material, allowance has been made for such charges as: 1½ percent of contract price for Surety Bond, about 9 percent of labor cost for compensation insurance, .6 of 1 percent for fire

TABULATION OF ESTIMATED COSTS OF CONSTRUCTION OF THE HOUSE TYPES PRESENTED UNDER "FARM HOUSE DESIGN"

SECTION OF THIS REPORT , EXPRESSED IN A UNIT PRICE PER SQUARE FOOT OF THE FLOOR AREA.

ITEM	TOTAL AREA	USABLE FLOOR AREA	AREA USED BY PARTITIONS & STAIRWAYS		COST PER SQ.FT. EXCLUSIVE OF PLUMBING	COST OF HOUSE EXCLUSIVE OF BASEMENT, PLUMBING AND EXTERIOR PORCHES	COST PER SQ.FT. OF 1ST FLOOR TO BE ADDED FOR PLUMBING	TOTAL COST OF COMPLETE HOUSE WITH PLUMBING, ELECTRICITY. BUT WITHOUT A BASEMENT OR EXTERIOR PORCHES
Stage 1	Sq. Ft.	Sq. Ft.	Sq. Ft.	per cent				
House 1	483	422	61	12.6	$2.15	$1039.00	No	No
House 2	578	505	73	12.6	2.15	1243.00	BATHROOM	BATHROOM
House 3	679	596	83	12.2	2.15	1460.00		
Stage 2								
House 1 a	628	539	89	14	2.30	1444.00	No	No
House 2 a	764	654	110	14.4	2.35	1795.00	BATHROOM	BATHROOM
House 3 a	840	724	116	13.8	2.35	1974.00		
Stage 3								
House 1 b	724	619	105	14.5	2.40	1738.00	$ .41	$2035.00
House 2 b	840	720	120	14.5	2.40	2016.00	.35	2310.00
House 3 b	936	804	132	14.1	2.40	2246.00	.33	2555.00

Stage 4	1st floor	2nd floor	1st floor	2nd floor			(1st floor finished only)	(to fin. 2nd floor)	(1st floor finished only)	(to fin. 2nd floor)		
House 1x-1½story	720	330	590	260	200	19.0	$2.70 *	$ .50	$1872.00*	$165.00	.41	$2404.00
House 2c-1 "	912	---	756	---	156	17.1	2.40	--	2189.00	------	.33	2490.00
House 2x-1½ "	812	309	664	260	196	17.0	2.70 *	.50	2192.00*	154.50	.35	2631.00

NOTE: (1) Plumbing includes kitchen sink, complete bath, hot water tank, hot and cold water, septic tank and disposal field.

(2) No porches requiring separate roofings or foundations, are included in these estimates.

* Indicates stairway to second floor.

For complete concreted basement add $.76 per sq. ft. of its area .
For Porches- Add $1.25 per sq. ft. of their area.

insurance, 10 percent for contractor's overhead, and 10 percent contractor's profit. Naturally, if any of these items of overhead can be materially reduced in actual practice, the estimates may be lowered accordingly.

To simplify estimating, the total estimated costs are expressed in a unit cost per square foot. Costs of porches, requiring a separate roof and additional foundation, are not included in these estimates, as they are partly ornamental in function and not generally agreed upon as essential.

The building of these same houses with union wage scale labor, increases the cost from 15 to 20 percent, according to rate.

The awarding of 10 to 15 houses to one contractor reduces the cost of each by about 4 percent, and the awarding of more than 15 under one contract saves about 6 percent per house.

Summary. The information revealed by this tabulation is: that a simple house, divided into the minimum recommended spaces with partitions affording privacy only, and exclusive of plumbing, porches or basement, would cost in the early spring of 1941 about $2.15 per square ft. of the floor area; that in houses with the same size and arrangement of rooms but with the recommended storage space added, would cost about $2.30 per square foot of the floor area of a one bedroom house, and about $2.35 per square foot of the floor area of a two and three bedroom house; that the reason for the increase in the square foot unit cost is the increase in the floor area occupied by the extra partitions: that the smaller the space the greater the amount of space taken by partitions in proportion to the usable floor space enclosed by them: that this fact also accounts for the increase in cost per square foot to $2.40 when bathroom space is incorporated into the design: that the estimated minimum costs at which it is possible to build a house by contract, with rural labor, and according to the specifications contained in this report, complete with bath and electricity, exclusive of "built-ins", porches and basements, in the early Spring of 1941, are:

$2035.00	for a one bedroom	one story type	1b
2310.00	" " two "	" " "	2b
2555.00	" " three "	" " "	3b
2404.00	" " three "	story and a half type	1x
2631.00	" " four "	" " " " "	2x

These costs, based on union wage scale, will be increased by 15 to 20 percent. To give a more comprehensive idea of house construction costs, and also to dispel the idea that an adequate, substantial house can be built for a thousand dollars or less; there follows a tabulation of estimated costs of the principal items of construction, EXCLUSIVE OF THE HOUSE ITSELF.

This tabulation reveals that these items account for approximately 50 percent of the cost of a plain simple house.

TABULATION OF ESTIMATES FOR THE PRINCIPAL ITEMS OF CONSTRUCTION OF THE DIAGRAMATIC HOUSES
OTHER THAN THE HOUSE ITSELF

DIAGRAM	FOUNDATION		DOORS Incl. H'dwe.		WINDOWS 15% floor area		CHIMNEY & FLASHINGS		ELECTRIC		SHINGLES Roof Pitch 7/12		PAINTING Exterior & Interior Exterior Tot.		KITCHEN CABINETS	TOTAL
	Cu. Yds.	Cost	No.	Cost	Sq. Ft.	Cost	LIN. Ft.	Cost	Outlets	Cost	Squares	Cost	Squares	Cost	Cost	
1	6	$90.00	4	$44.00	64	$80.00	20'	$35.00	6-3s*	$34.00	7	$42.00	10½	$150.00	None	$470.50
2	6½	98.00	5	55.00	75	94.00	20'	35.00	7-4s	41.00	8	48.00	11	156.00	"	512.00
3	7	105.00	6	66.00	90	112.50	20'	35.00	8-5s	49.00	9½	49.00	12	171.00	"	589.50
1a	8	120.00	9	99.00	81	101.00	20'	35.00	9-3s	45.00	8½	45.00	12½	178.00	$68.00	696.50
2a	9½	143.00	11	121.00	99	124.00	20'	35.00	11-4s	56.00	10½	63.00	13½	192.00	68.00	802.00
3a	10	150.00	12	132.00	111	139.00	20'	35.00	11-5s	68.00	11½	69.00	14	200.00	68.00	861.00
1b	9	135.00	10	110.00	93	116.00	20'	35.00	11-4s	56.00	9½	57.00	13	185.00	68.00	762.00
2b	10½	158.00	12	132.00	108	135.00	20'	35.00	12-5s	68.00	11	66.00	14	200.00	68.00	862.00
3b	11	165.00	13	142.00	120	150.00	20'	35.00	15-6s	79.00	12½	75.00	15	214.00	68.00	931.00
2c	9	135.00	12	132.00	114	142.50	20'	35.00	13-5s	68.00	12 (10/12 pitch)	72.00	14	200.00	68.00	855.50
1x	8	120.00	13	143.00	127	159.00	30'	53.00	16-6s	83.00	10½	63.00	13½	192.00	68.00	881.00
2x	9	135.00	13	143.00	136	170.00	30'	53.00	17-7s	90.00	11	66.00	14½	207.00	68.00	932.00

* S- Switches

Note : Add $250.00 for complete plumbing.

Estimate Basis:

Foundation Concrete	-	$ 15.00 cu. YD.
Doors, frames & Hardware	-	11.00 each
Windows and Screens	-	1.25 per sq. ft. installed
Plastered flue Chimney (including flashings)	-	1.75 lin.ft.
Wiring at	-	3.75 per outlet
No. 1 Shingles (laid)	-	6.00 per square (Shingles $4.50, labor $1.50 per square)
Painting 3 coats (Ext.)	-	4.75 per 100 sq. ft. (75 per hr., Paint $2.60 per gal.) Porches not included
Painting Interior	-	Double amount allowed for exterior
Kitchen Cabinets	-	8.00 per running ft. (labor 1.00 per hr.) Minimum 8½ ft. long.

OUTBUILDINGS

A great many varieties of outbuildings are used on farms, ... such as barns, with and without hay lofts, poultry houses, milk houses, garages, machinery sheds, hog houses, corn cribs, and silos. The types of outbuildings to be constructed depend upon the size of the farm, the climate, and the type of farming practiced. The size and the design of each type is influenced by the facilities required, the individual desire of the farmer, and the amount of funds available for construction. Almost any farm requires several outbuildings, although it is very rare for a farmer to construct all of the outbuildings at once, especially when breaking in new land.

This report cannot enter into a detailed explanation of the advantages and disadvantages of various kinds of outbuildings (especially barns) and the facilities which they provide, rather, this discussion will be confined to the cost and design of three buildings which the Farm Security Administration has regarded as being essential for the operation of diversified family size farms.

In the building construction program for resettlement projects and tenant purchase farms, it has been the practice of the FSA to include a barn and poultry house in the initial improvement of the farm. In some cases, where the farm is strictly of the dairy type, and where the chief income of the farmer would be from the sale of milk products, a milk house is included. In order to keep the cost of these improvements as low as possible, but at the same time provide the essential facilities, low cost types have been designed for various parts of the Northwest.

The climate of the Columbia River Basin is generally similar to that of the Vale-Owyhee Project in Oregon, and the Black Canyon Project in Idaho. Due to the low annual rainfall of these three areas, the practice of stacking hay in the open usually eliminates the necessity of constructing a barn with a hay loft. In areas where hay is stored in this manner the cattle are supplied hay from the outside of the barn.

As an example of the type of barn recommended by the FSA for use on the Vale-Owyhee and Black Canyon Projects, and one which can be readily adapted to the program of the Columbia Basin, there is attached a blueprint of a barn without a hay loft, planned for outside feeding, and for housing ten cows and four horses. The outside dimensions of this barn are 17' x 53', comprising 901 sq. ft. This type of barn is so designed that the amount of space allowed to the cows can be readily expanded or reduced without a major revision of the plan. Also a barn of this simple design can be constructed with use of unskilled labor more satisfactorily than one larger and of more complicated design.

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The estimated cost of this building as of May, 1941, is $817.00 for material and $564.00 for labor, totaling $1381.00, or $1.54 per sq. ft. These figures are based on rural wage rates and No. 2 framing lumber. This building, however, can be constructed by the owner for about $800.00, by using his own labor and the services of an experienced carpenter in erecting the framing. This allows $100.00 for the hiring of the carpenter, plus the cost of materials. This would reduce the cost per sq.ft. to approximately 90¢.

The above figure of $1.54 per sq. ft. can be used for rough estimating of the cost of other outbuildings, such as the garage, or any other building of similar construction enclosed by four walls.

If an area of 3' x 17' is allowed for the housing of one cow, multiples of 3' could be deducted from the length to house fewer cows instead of ten. Thus the total cost of the barn is reduced by approximately $78.00 per cow. If the barn is enlarged to house more cows, then additional cost would also be approximately $78.00 per cow.

Barns containing hay lofts, similar to the plan No. 411-115 attached, which has a first floor area of 1440 sq. ft., cost about $2575.00 when constructed on contract.

POULTRY HOUSE:

The poultry house most frequently recommended by the FSA to house the family flock, is one of fifty or one hundred bird capacity. There is attached a plan for a "Standard 18 x 20 Poultry House" with a floor area of 360 aq. ft., which will house from 80 to 100 birds, according to the breed. The average of the recent bids for the construction of this poultry house, with a cement floor, has been about $400.00, or $1.12 per sq. ft. Approximately 5¢ per sq. ft. can be saved by substituting a wooden floor, if preferred.

MILK HOUSE:

The type of milk house will vary, depending upon whether the production of milk is to comply with Grade B or Grade C marketing requirements. The principle difference between the two milk houses is that the plan for Grade B marketing must include cooling facilities. There is attached a plan of each type of milk house most frequently used on FSA farms requiring these buildings. The following estimated costs of these two buildings are based on a floor plan of 9' x 12' dimensions.

Milk house (9 x 12) to meet Grade C Production Requirements:

$1.85 per sq. ft. by contract = $200.00

Milk house (9 x 12) to meet Grade B Production Requirements:

$3.70 per sq. ft. by contract = $400.00

$3.70 per sq. ft. by contract = $600.00

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In addition to the above outbuildings, the District Engineer's Office of Region XI, Farm Security Administration, has plans available for other outbuildings of various capacities.

OPTIONAL PROCEDURES OF CONSTRUCTION

The cost estimates for the construction of farm houses and the outbuildings, as presented in the foregoing discussion, have been computed on the basis of experience where the building contract method was used, and rural wage rates were paid. The reader is warned against readily concluding that the costs can be materially reduced for similar buildings if these circumstances of construction prevail. Earnest efforts in this direction have already been made.

Since the amount of material and labor is fixed and governed by current market prices, the only opportunity for substantially reducing the costs of these structures is to eliminate the contractor's profit and overhead, and reduce the cost of the labor by having the farmer perform the labor himself.

Before this alternate method can be determined as practical, a division of the cost of construction into labor and material will have to be made in order to determine what proportionate amounts are involved.

It is an established fact that approximately 40% of the total cost of a house built by contract, with rural construction labor, is consumed by labor. On this basis the cost of the various designs presented in the fore part of this report, divided into labor and material would be as follows:

House	Cost Carried Over From Table 1. (Contract Price)	Material 60%	Labor 40%
1	$ 1039.00	$ 623.00	$ 416.00
2	1243.00	746.00	497.00
3	1460.00	876.00	584.00
1 a	1444.00	866.00	578.00
2 a	1795.00	877.00	718.00
3 a	1974.00	1184.00	790.00
1 b	2035.00	1221.00	814.00
2 b	2510.00	1586.00	924.00
3 b	2555.00	1533.00	1022.00
1 x	2404.00	1442.00	962.00
2 c	2490.00	1494.00	996.00
2 x	2710.00	1626.00	1084.00
Barn	1384.00	831.00	553.00
Poultry House	400.00	240.00	160.00
'C' Milk House	200.00	120.00	80.00
'B' Milk House	400.00	240.00	160.00

The column of the above tabulation setting forth the labor amounts represents the possible savings that can be made by a farmer who would undertake the construction of his own house without the aid of hired labor. This is assuming that the farmer possesses the necessary tools, and is personally qualified to perform both skilled and unskilled labor.

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1 x	2404.00	1442.00	962.00
2 c	2490.00	1494.00	996.00
2 x	2710.00	1626.00	1084.00
Barn	1384.00	831.00	553.00
Poultry House	400.00	240.00	160.00
"C" Milk House	200.00	120.00	80.00
"B" Milk House	400.00	240.00	160.00

The column of the above tabulation setting forth the labor amounts represents the possible savings that can be made by a farmer who would undertake the construction of his own house without the aid of hired labor. This is assuming that the farmer possesses the necessary tools, and is personally qualified to perform both skilled and unskilled labor.

In the case of the construction of the 3 b house, he could theoretically save $1022.00, in addition to the contractor's profit and overhead amounting to about 15% of the total cost. Again, it is assumed that farmers are qualified to perform skilled labor, such as finished carpentry, masonry, and installation of electric and plumbing facilities.

As stated previously in this report, approximately 25% of the total labor in the cost of the house is for skilled labor, involved in the plumbing, electric wiring, masonry work, and interior millwork. Deducting $255.00, as an allowance for hired skilled labor, from the total labor figure of $1022.00, as given above, leaves a balance of $767.00, as a possible savings to the farmer by performing the remainder of the labor himself. His own overhead costs would be substantial, since he would have to pay for hauling, fire insurance, and compensation insurance. Nevertheless the net difference in cost would represent a great saving and would be recommended as practical in the case of the exceptionally capable farmer, except for the time factor involved in the construction of a house. If the items of labor presented in the foregoing tabulation are analyzed from the standpoint of time, such an analysis would appear as follows:

Item	Labor 40%	Man * Hours	Man ** Days	Deducting *** 25% for hired skilled labor	Man Days Left For Farmer
House 1	$ 416.00	555	69	17	52
House 2	497.00	663	83	21	62
House 3	584.00	779	97	24	73
House 1 a	578.00	770	96	24	72
House 2 a	718.00	959	120	30	90
House 3 a	790.00	1053	132	33	99
House 1 b	814.00	1085	136	34	102
House 2 b	924.00	1232	154	38	116
House 3 b	1022.00	1363	170	42	128
House 1 x	962.00	1283	160	40	120
House 2 c	996.00	1328	166	41	124
House 2 x	1084.00	1452	182	45	137
Barn (17'x53')	553.00	737	92	23	69
Poultry House (18'x20')	160.00	213	26	6	20
'C' Milk House	80.00	107	13	3	10
'B' Milk House	160.00	214	26	6	20

* An average of $.75 per hour for rural areas (25% $1.25 per hr., 25% $.75 per hr., 50% $.50 per hr.)

** Eight hour day

*** Plumbing, masonry, wiring, expert carpenter on interior millwork.

Column 2 represents the cost of labor involved in the construction of the house type shown in column 1. Column 3 indicates the man hours derived from dividing the total amount of labor by $.75 per hour, the average labor cost as presented previously; Column 4 represents the man days. Column 5 represents the number of man days of hired skilled labor, and column 6 indicates the man days remaining for the farmer to perform. Thus, the construction of a three bedroom house such as represented by house 3 b

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would require 128 days, or a little over four months, of his own labor, working eight hours per day and including Saturdays and Sundays. In other words, theoretically, he would have to devote all of his time to the construction of his house for at least four months. In fact it would be impossible for him to perform the labor in this length of time, if he were working alone. By this is meant that two men working on a construction job can usually perform more work in one day than one man could possibly do in two days, due to the element of cooperative endeavor in such work as handling rafters and siding.

Let it be remembered that the proposed farms of the Columbia Basin will be constructed on virgin raw land, with no existing buildings. For a farmer to undertake the construction of his own house under these circumstances, it would be necessary for him to work several months without shelter, and during that time the building material would be exposed to the weather, and subject to deterioration. This factor is of more importance than would at first be assumed.

During the same period that the farmer would be constructing his buildings, there would be a definite competition for his time in many other tasks which are involved in farm development. Under these circumstances, if he devoted half his time to farm work he would postpone the finishing of his house about four additional months.

In the experience of the FSA in experimenting with this alternate method of construction for a group of houses near Gooding, Idaho, it developed that the farmers, with all of their other pressing duties, neglected the finishing of their houses as soon as they had provided roofs over their heads. There are still three or four houses out of twelve which were built that have not as yet been completed, although they were begun during the summer of 1938.

Perhaps another analysis of the construction of the 3 b house should be added here, to show how long it would take one man alone to construct this house. This analysis subdivides the construction into twenty phases of the work involved, expressed in the percentages and respective amounts of the total cost.

		Percent	Amount
1.	Excavation and Backfill	1.3	$ 33.22
2.	Footings, walls and piers	5.6	143.08
3.	Studs, sills and plates	5.0	126.47
4.	Rough flooring, joists & roof rafters	10.2	261.89
5.	Chimney and flashings	1.7	43.44
6.	Sheathing and siding	10.8	275.94
7	Roofing (shingles)	3.1	79.20
8.	Interior wall finish (lath & plaster)	7.2	183.96
9.	Ceiling finish	5.6	143.08

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		Percent	Amount
10.	Finished Floor	4.3	$ 109.86
11.	Doors, Windows and Screens	11.5	293.00
12.	Miscellaneous Millwork & Trim	4.9	124.90
13.	Kitchen Cabinet (8½ feet)	2.5	65.00
14.	Hardware	2.5	63.87
15.	Electrical	3.4	86.87
16.	Plumbing	9.6	245.28
17.	Painting (Exterior)	2.6	66.43
18.	Painting (Interior)	5.1	130.30
19.	Clean up	.9	23.00
20.	Contingencies	2.2	56.21
	TOTALS	100.00	$2555.00

The first seven items account for the construction to the beginning of the interior work. The structure has been enclosed with exterior siding and shingles applied to the roof. Up to this stage, no doors, windows, finished floors, or interior walls have been completed. These items total 37.7 per cent of the final cost, or $963.24. Allowing 40% of this amount for labor, and interpreting the $385.00 thus derived into man days, it is determined that it would theoretically require approximately 62 eight hour days to reach this point of the construction.

The circumstances which have been described are mainly responsible for the present policy of the FSA in house construction. By the contract method a period of construction can definitely be established in the contract and the contractor alone is responsible for the performance of the work, under bond, and he assumes the risk of public liability, fire hazard, and workmen's compensation.

The new settler is provided with a shelter as quickly as possible, so that he can devote all of his time to the clearing and leveling of his land and the construction of his outbuildings and fences. His farm program is advanced a year, and his labor is used at tasks which he can perform competently.

Thus far the cost of a single house to the individual farmer has been the basis of the above discussion. However, there is still the possibility of awarding the construction of the houses in groups of twenty or more to a single contractor. The group is selected where the farms are as nearly contiguous as possible.

Approximately 6% on each house is saved by this method, due to the fact that the contractor can purchase the material in quantities, and can organize the phases of construction systematically and pre-cut all of the framing lumber with power saws. By this method about $150.00 can be saved on a house otherwise costing $2500.00

In the construction of the primary outbuildings, it has been the common practice of the FSA, in its tenant purchase program, to allow the

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In the construction of the primary outbuildings, it has been the common practice of the FSA, in its tenant purchase program, to allow the

construction of these buildings by the farmer on a basis other than contract, which creates a considerable saving to the farmer.

Because it takes less man hours to build the outbuildings than it does the house, and because the construction is comparatively simple and does not involve items of plumbing, electric wiring, masonry work, and interior finish, farmers have been encouraged to construct these improvements by their own chosen method, and using their own labor as far as possible.

A satisfactory method for construction of outbuildings would be provided by an arrangement where an expert carpenter were employed to assist the farmer in laying out the building and framing the structure. The farmer could perform the rest of the labor himself. This method would assure a substantial building and offer maximum opportunity for efficient use of the farm family's labor. The comparative cost per square foot and the total cost for building the 17' x 53' barn without hay loft mentioned above, by the farmer purchasing the materials and hiring the carpentering for this preliminary work, is as follows:

17' x 53' Barn - 901 sq.ft., by contract, $1.54 per sq.ft.,	-	$1384.00
Material and hiring all labor, $1.34 per sq.ft.	-	1204.75
Material, plus $100 allowance hired labor, plus owner's labor, $.90 per sq. ft.	-	811.00

The unit cost to house one cow is thus reduced from approximately $78.50 per cow, to $46.00 per cow.

From these figures, the cost of other buildings similar in type to barn construction can be readily estimated according to the respective method of construction. Using the same methods as stated above in the construction of the barn plan No. 411-115, which includes a hay loft, an 18' x 20' poultry house, and the two types of milk house, the comparative costs for the different methods would be as follows:

Barn No. 411-115, by contract, $1.78 per sq.ft., 1440 Sq.ft.	-	$2575.00
Material and all labor hired, $1.55 per sq.ft.	-	2232.00
Material plus $300.00 allowance for hired labor, plus owner's labor, $1.00 per sq.ft.	-	1440.00
Poultry House, 18' x 20', 100 bird capacity, by contract, $1.11 per sq. ft., 360 sq.ft.,	-	$ 400.00
Material plus all labor hired, $.94 per sq.ft.	-	340.00
Material plus $50.00 allowance for hired labor, plus owner's labor, $.61 per sq.ft.	-	220.00
Milk House 'C', (9'x 12')		
By contract, $1.85 per sq.ft., 108 sq.ft.	-	$ 200.00
Material and all labor hired, $1.57 per sq.ft.	-	170.00
Material plus $50.00 allowance for hired labor, plus owner's labor, $.61 per sq.ft.	-	135.00
Milk House 'B', (9' x 12')		
By contract, $3.70 per sq.ft., 108 sq.ft.	-	$ 400.00
Material and all labor hired, $3.14 per sq.ft.	-	340.00
Material plus $100.00 hired labor, plus owner's labor, $2.50 per sq.ft.	-	270.00

FENCING:

Another essential improvement on a farm is the fencing. Where farms, on an average, would consist of 80 acres, the average perimeter of each individual farm would equal approximately 1½ miles of fence. However, several parts of boundary fences will be common to at least two farms. Thus, on an average, the amount of fence necessary to enclose each farm can be considered as requiring one mile of fencing. This improvement the farmer can accomplish with his own labor.

With the posts spaced a rod apart, and costing 15¢ apiece, and allowing 5¢ per rod of fence for the wire and staples, the cost of the material would be approximately 35¢ per rod. For a mile of fence, or 320 rods, the total cost of the material is approximately $110.00.

RECOMMENDATIONS

Domestic Water Supply

It is recommended:

1. That the drilling of wells for domestic water supply shall precede the construction of improvements and the selection of farmsteads;
2. That the average depth of the wells shall be anticipated to be between 300 and 450 feet;
3. That the drilling of wells be awarded by contract, although the cooperative method may be used to some extent to establish "yardstick" costs;
4. That water users associations be established, consisting of, if possible, at least 4 farms to a well, and connected by no more than 1/2 miles of pipe per farm;
5. That the farmers purchase the casing and pumping equipment cooperatively;
6. That all trenching for piping to connect the users from one well be dug with trenching machines, either by contract by the lineal foot, or by cooperatively owned machinery;
7. That an amount of $1200 be allowed for providing water to each farm until experience shows what the actual cost will be in the various communities.

Housing

It is recommended:

1. That farm houses contain at least 3 bedrooms and a bath, or be of such

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Housing

It is recommended:

1. That farm houses contain at least 3 bedrooms and a bath, or be of such

design that they are capable of being expanded to three bedrooms and a bath with the least amount of expense;

2. That the living and storage spaces recommended herein be considered minimum requirements;

3. That running water, electric wiring and waste water drain systems, be provided;

4. That as a rule construction shall be handled by the contract method in order to insure that durable structures and a satisfactory value for funds expended, be obtained;

5. That where possible savings be obtained by awarding construction contracts for groups of houses of 20 or more under one contract;

6. That in the absence of a well planned and effective program of instruction and technical assistance in house building, the settlers shall not be expected to construct houses solely by the use of their own labor, since the construction of a permanent house requires skills, experience, and tools which most farmers do not possess.

Outbuildings.

It is recommended:

1. That wherever a major use of farm family labor is to be made in building construction that this labor be used on the outbuildings such as barns, poultry houses, milk houses, and garages;

2. That assistance be provided, however, to insure that the building layout and framing is performed according to approved standards.

3. That for diversified dairy farms, shelter for dairy livestock and for family flocks of chickens be provided at the same time that other basic improvements are constructed.

General

It is recommended that careful attention be given to the fact that farm land development and farming operations will be in competition with the construction of the farm buildings as claims upon the labor of farm families, if it is contemplated that families perform much labor in building construction.

It is recommended also that attention be given to the possibility that considerable waste of materials, and inefficiency, will be involved if families who are inexperienced in building construction undertake to build their own houses.

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It is recommended that careful attention be given to the fact that farm land development and farming operations will be in competition with the construction of the farm buildings as claims upon the labor of farm families, if it is contemplated that families perform much labor in building construction.

It is recommended also that attention be given to the possibility that families who are inexperienced in building construction undertake to build their own houses.

It is recommended that consideration be given to the possibility of

providing temporary shelter for farm families during the farmstead development and settlement period, by means of cheap portable dwellings or mobile camps similar to those used in the FSA migratory labor camp program.

It is recommended that for diversified family sized farms, an amount of $5000 be allowed for farmstead and fencing improvements, in the preparation of farm budgets, and development of a program of financial aid. The amount is broken down as follows:

Domestic Water Supply	Total	$1200.00
House: Containing 3 bedrooms and with complete bath, built by contract. The 6% saving by group award to allow for cost of porches and variations of exterior	Total	2550.00
Barn: (17' x 53') having a capacity for 10 cows, 4 horses, no hay loft. Total material, plus owner's labor and $100 allowance for hired labor	Total	810.00
Poultry House: (18' x 20') capacity 80 to 100 birds, with concrete floor. Total material, plus owner's labor and $50 allowance for hired labor	Total	220.00
Milk House: (9' x 12') to comply with 'C' Grade production requirements, or outbuildings of no greater cost. Total material, plus owner's labor, and $100 allowance for hired labor	Total	135.00
Fencing: One mile of 4 wire, barbed wire fence, material only	Total	110.00
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Domestic Water Supply — Total $1200.00

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contract. The 6% saving by group award to allow for cost of
porches and variations of exterior — Total 2550.00

Barn: (17' x 53') having a capacity for 10 cows, 4 horses, no
hay loft. Total material, plus owner's labor and $100 allow-
ance for hired labor — Total 810.00

Poultry House: (12' x 20') capacity 80 to 100 birds, with
concrete floor. Total material, plus owner's labor and $50
allowance for hired labor — Total 220.00

Milk House: (9' x 12') to comply with 'C' Grade production
requirements, or outbuildings of no greater cost. Total
material, plus owner's labor, and $100 allowance for hired
labor — Total 135.00

Fencing: One mile of 4 wire, barbed wire fence, material
only — Total 110.00

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N. C. JANNSEN DRILLING COMPANY C O P Y

P. O. Box 3182
SEATTLE, WASHINGTON
September 10, 1940

Washington State Planning Council
400 Old Capitol Building
Olympia, Washington

Gentlemen: Attention: Mr. P. Hetherton

We have your letter of August 31, 1940. Please excuse me for not answering sooner, my reason being that I have been out of town.

We have drilled a great many wells in the district mentioned in your letter. Most of the wells will run a great deal deeper than you suggest, running 350 to 400 feet. The farther you go west from Qunicy, the deeper they are going to run. The wells in and around Ephrata, east and south, especially around Moses lake will run in the neighborhood of 150 feet.

When you go down toward Frenchman Hills and Othello, the wells will run 300 to 400 feet. We drilled a well west of Qunicy that ran 600 feet in solid rock from the grass on down.

In drilling these wells, we would recommend that a 8 inch hole be drilled rather than a 6 inch, as it would give you a little more leeway for straightness. If these wells are not drilled with big heavy tools, they are going to deflect, resulting in a crooked hole. A crooked hole may serve you for the time being, but they are a source of trouble and expense for the reason of pump rods wearing out. Crooked holes are due mostly to light inefficient drilling equipment.

No. 1 The cost of driving well. The cost would be governed by the amount of work to be had. If we were given a blanket contract that would warrant the setting up of a Headquarters, machine shop, tool house and the heaviest kind of equipment, drilling a 8 inch hole would run $5.00 a foot on large scale operations. The cost of pumping equipment will vary as to depth. A deep well will require heavier pumping equipment than a shallow well. I would recommend an under ground pressure tank on account of the heat in the summer and cold in the winter. The pressure tank would not necessarily have to be a large one for a water supply for domestic purposes.

I would estimate the cost would run about $750.00 per unit. A shallow well running about $500.00 and a deeper one about $1,000.00.

No. 3 The cost of piping, that will only be determined by the distance each house will be from the plant. A 3/4 inch pipe not to exceed one inch would serve for a domestic water supply, determined by the distance you would have to run the water due to friction loss in the pipe and would have to be put in a ditch not less than 3½ feet deep.

The cost of the pipe, you can get as well as I. Digging and backfilling can be done for about 20 cents a foot.

We have logs for a number of wells drilled in that country and you are at liberty to come in and select the log you wish.

Thanking you for calling on us, we are

Very truly yours,

N. C. Jannsen Drilling Company

/s/ N. C. JANNSEN

NCJ-W

D640759

N. C. JANNSEN DRILLING COMPANY

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SEATTLE, WASHINGTON
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Washington State Planning Council
400 Old Capitol Building
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Gentlement Attention: Mr. P. Hetherton

We have your letter of August 31, 1940. Please excuse me for not answering sooner, my reason being that I have been out of town.

We have drilled a great many wells in the district mentioned in your letter. Most of the wells will run a great deal deeper than you suggest, running 350 to 400 feet. The farther you go west from Gumley, the deeper they are going to run. The wells in and around Ephrata, east and south, especially around Moses Lake will run in the neighborhood of 150 feet.

When you go down toward Frenchman Hills and Othello, the wells will run 300 to 400 feet. We drilled a well west of Gumley that ran 600 feet in solid rock from the grass on down.

In drilling these wells, we would recommend that a 8 inch hole be drilled rather than a 6 inch, as it would give you a little more leeway for straightness. If these wells are not drilled with big heavy tools, they are going to deflect, resulting in a crooked hole. A crooked hole may serve you for the time being, but they are a source of trouble and expense for the reason of pump rods wearing out. Crooked holes are due mostly to light inefficient drilling equipment.

No. 1 The cost of drilling well. The cost would be governed by the amount of work to be had. If we were given a blanket contract that would warrant the setting up of a Headquarters, machine shop, tool house and the heaviest kind of equipment, drilling a 8 inch hole would run $5.00 a foot on large scale operations. The cost of pumping equipment will vary as to depth. A deep well will require heavier pumping equipment than a shallow well. I would recommend an under ground pressure tank on account of the heat in the summer and cold in the winter. The pressure tank would not necessarily have to be a large one for a water supply for domestic purposes.

I would estimate the cost would run about $750.00 per unit. A shallow well running about $500.00 and a deeper one about $1,000.00.

No. 2 The cost of piping, that will only be determined by the distance each house will be from the plant. A 3/4 inch pipe not to exceed one inch would serve for a domestic water supply, determined by the distance you would have to run the water due to friction loss in the pipe and would have to be put in a ditch not less than 3½ feet deep.

The cost of the pipe, you can get as well as I. Digging and backfilling can be done for about 20 cents a foot.

We have logs for a number of wells drilled in that country and you are at liberty to come in and select the log you wish.

Thanking you for calling on us, we are

Very truly yours,

N. C. Jannsen Drilling Company

/s/ N. C. JANNSEN

NCJ-M

D64075S

Appendix A

ADOBE CONSTRUCTION

Adobe construction developed in the southwest, in Arizona, New Mexico, and Mexico, long before irrigation was introduced into this territory. It was used because it was the only building material available at that time in this mild, arid region, where rainfall was light, frost penetration little or none, and the soil of a type that when mixed with water and straw, would dry hard enough in the sun to form bricks. These could be laid in walls, using a mortar made of the same soil of which the bricks were made. The thickness of the walls varied from 8" to 2 feet, depending upon the size of the building, and the judgment of the builder.

Since ground moisture was non-existent and the winters mild, frost was no consideration. Therefore walls would be laid without a prepared foundation, by simply clearing away the loose soil and vegetation where the walls were to be. Little or no expense was incurred in providing windows, because the fewer of these, the cooler the house was in the summer time. The house could be kept warm in winter by covering the openings with drapes.

The function of the roof was more to provide a shady cool interior than to shed rainfall. Therefore the roof was made flat, of poles for rafters, to support the covering of straw, brush, and earth. Whether the roof leaked occasionally was a matter of little consequence.

These houses were small and one story in height as a rule. Providing a floor was a simple matter, - just a layer of adobe bricks or the mud laid on the ground and smoothed off. There was no moisture in the ground to dampen or damage the floor by capillary action, nor was it cold enough to make such a floor uncomfortable.

Even under the ideal climatic conditions for this water absorbing type of construction, occasional rain, frost, and wind often caused damage to the outside wall surfaces, which were preserved by applying a coat of mud plaster or by patching from time to time. The lifetime of the structure depended on the maintenance it received. The building of a house and maintaining it involved only labor, which was plentiful and cheap.

When adobe construction came into use by people of a higher standard of living, refinement and decoration of the interiors took place. This, and a better quality of household goods, plus modern improvements and appliances, called for more substantial leak proof roofs. To cut maintenance of exterior wall surfaces to a minimum, cement plaster was applied as an outside coating.

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More rooms were added for privacy, which added more doors and window openings. Then glazed sash, screens, hardware, electricity, plumbing, and painting entered the picture. These features have added costs which are common both to adobe and wood construction. Along with these improvements construction details became more complicated. The question then arises: For the same type of housing, with similar improvements, conveniences, and durability, is adobe construction actually cheaper?

In recent years banks and investment companies established certain standards of construction for the safety of the investment and incidently the safety of the borrower. These requirements have become standardized to suit the climatic and geographic conditions of Arizona, New Mexico and California, and have been adopted as the minimum essentials by many agencies, including the Federal Housing Administration and the Farm Security Administration, that are engaged in building and financing adobe construction. For instance the minimum thickness of the first story walls of two story structures, required by F. H. A. in California is two feet for exterior walls, compared to the minimum requirement of 18" in Arizona, and 20" in New Mexico. Undoubtedly the reason for this is the added safety required due to California's susceptibility to earthquakes.

If adobe construction were used in the Columbia Basin irrigated area, moisture and frost resistant features would be absolutely necessary. Description of these features is included in the following resume of construction methods.

Foundations. The most satisfactory type of foundation for adobe brick houses is one of reinforced Portland cement concrete. Masonry foundations are also satisfactory, although they do not have the beam strength in the event of uneven settlement as does reinforced concrete. Both types of foundation add appreciably to the cost of construction. The foundation should extend in depth to a point below frost penetration, and in height about 6" to 8" above the ground. This latter feature is to protect the wall from rain water splash. The thickness of the foundation must be at least the thickness of the house walls, and if wood floors are used, additional thickness is required to support floor joists. It is advisable to have a damp-proofing course between the foundation and the walls to prevent dampness from rising in the wall, even though stabilized bricks are used.

A really satisfactory foundation will require about three times the amount of concrete necessary for the foundation of a frame structure. Any attempt to modify appreciably the requirements of an adequate foundation, to reduce costs, will probably result in early depreciation of structures.

If adobe houses are built in irrigated areas directly on the ground, or without frost and moisture safeguards, they will soon weaken to the point of collapse.

Bricks. The stability of adobe depends partly on the quality of the bricks, and therefore on the kind of earth used, and the curing process.

Adobe brick should have an utlimate compression strength of 350 lbs. per square inch or a compressive working strength of 25 lbs. per square inch. In order to overcome variations of strength due to slight variation in the soil and also to water proof the bricks, the adding of asphalt emulsion, called a stabilizer, has been introduced into adobe construction. This product, which mixes with water, is added to the mud at the time the bricks are made. Due to freezing weather during the rainy season which would cause damage to outside walls made of water absorbing material, the District Engineers Office of the FSA, having had experience in both types of construction under the supervision of experienced members of its personnel, would not approve adobe construction in the Columbia Basin that was not stabilized.

The soil selected for the manufacture of the stabilized adobe brick does not necessarily have to be of a true adobe type. In fact true adobe soils are generally unsatisfactory for the manufacture of the brick because of their high shrinkage and tendency to crack upon drying. Best results are obtained with soils composed of clay and sand in which the clay has good binding properties and there is sufficient sand to prevent excessive shrinkage or cracking. It is sometimes advisable to combine two or more soils to secure the proper strength with a negligible amount of shrinkage. For example clayey soils can be modified by the addition of sand, whereas sandy soils can be improved in strength by the addition of clay.

The addition of straw, chopped into lengths of two or three inches, is common practice in the manufacture of large size bricks (12" x 16" x 4") the purpose being to provide breather tubes to aid evaporation of the moisture from the interior of the brick, thus preventing surface cracking and warping upon drying. It is very doubtful if the addition of straw adds any strength to the brick in compression, but it may have some advantage in improving its tensile strength or toughness.

To make the brick, the soil is made plastic by the addition of water and thorough mixing either by hand or with mechanical mixing devices such as a plaster mixer, concrete mixer, or pug mill type mixer. The stabilizer (asphalt emulsion) is added with the mixing water in an amount sufficient to develop the desired water-proofing characteristic. The quantity used is, in general, dependent upon the grading of the soil, especially as regards

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the percentage of clay and silt passing the 200 mesh sieve. The effectiveness of emulsified asphalt varies with different soils. Therefore the quantity of emulsion to be used (usually between 4% and 8% by weight of the soil or about ½ gallon per cubic foot of soil) should be determined by mixing different quantities of emulsion with the soil and after molding into bricks and drying, observing their relative resistance to capillary moisture and also immersion in water.

After the soil has attained a uniformly plastic condition, the bricks are generally molded by hand, using rectangular wood frames of proper inside dimensions placed either directly on the smoothed ground surface, preferably covered with a thin layer of sand, or supported by rectangular wood pallettes covered with a sheet of paper or otherwise treated to prevent the brick from adhering.

After the bricks are molded, the rectangular frame is immediately withdrawn and cleaned with water before re-use. The brick is allowed to dry in its original flat position for several days, when it will become strong enough to stand on edge to permit drying from both sides. The time required thoroughly to dry the brick will be from thirty to sixty days depending on weather conditions. It is essential that the brick be as dry as possible to minimize shrinkage by further drying in the wall. The bricks are made first and the foundation made during the drying period.

Three experienced adobe brick makers can mold about 1000 bricks a day. One attends to the mixing, one carries the mixture by wheelbarrow to the molder, the third molds the bricks.

Laying Up The Walls. Stabilized adobe brick are generally laid in a mortar of the same soil as was used for the brickmaking. It also is stabilized, with about 50% more emulsified asphalt than was used in the brick mixture. The mortar joints are approximately one-half inch in thickness to allow for irregularities in the brick. The laying operations are similar to those used with burnt brick, particular care being taken thoroughly to fill all joints and thoroughly to band all corners.

The use of wire reinforcing such as barbed wire, expanded metal, or chickenwire netting, adds greatly to the strength of the wall. Such reinforcing can be installed in the mortar joint of every third or fifth layer, and should, as far as possible, be continuous around the length of the exterior walls. The several courses of brick should be laid continuously around the walls instead of building up the corners as is customary with burnt brick. This prevents excess loads on fresh mortar joints with resultant settlement and possible cracking.

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Three men will lay about 1000 bricks in the wall a day. One to transport the brick, one to mix and supply the mortar, and the third to do the laying. It is better to allow a day or two to intervene between one day's laying and the next, to allow the mortar to dry out and prevent settlement.

Doors and Window Openings. It is generally the practice to block out openings with temporary wood frames, and after the wall is constructed, install the finished frames. Nailing blocks or 2" x 4" vertical wood pieces fastened securely in the wall are necessary to hold the frame.

Door and window sills are usually made of Portland cement concrete, either as precast units or cast in place. For low cost structures, wooden sills are used, or the adobe brick are protected by a coating of cement mortar of one inch or so in thickness.

As adobe brick masonry has little beam strength it is necessary to provide adequate support to the walls over door and window openings by the installation of strong lintels, which may be solid wood timbers or of the built up box type. They should extend into the wall on each side of the opening at lea st nine inches for adequate bearing support. The lintels should also be constructed of a width equal to the thickness of the wall, and be placed above the height required for the finished frame, to allow for shrinkage, which may be as much as one inch in a ten foot height of wall. The allowance for shrinkage will depend upon the height of the openings.

To provide against lateral thrusts against the wall by roof trusses, the latter should be so designed that they will only transmit vertical loads to the wall. The wall itself should be provided with a reinforced concrete or timber collar around the perimeter at the top of the wall, to act as a tie and support to the roof. If the collar is to be constructed of concrete, it should be a minimum of six inches in thickness, and be reinforced by at least two reinforcing bars placed halfway the depth of the beam and about one inch in from each face of the wall. The concrete collar should be cast as a continuous beam around the entire perimeter of the wall. Before the concrete has set, suitable bolts should be imbedded at intervals to serve in fastening down a wood sill to which the roof framing can be installed.

If a wood type plate or collar is used, it should be fastened to the earth wall by suitable bolts or ties to provide lateral support.

Exterior walls are generally constructed not less than 12 inches thick for one story buildings and 18 inches thick for two story buildings. Bearing walls should not exceed 30 feet in length without lateral supports.

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Roof. Roofs with wide overhanging eaves, give maximum protection to the adobe walls from moisture. The matter of roof insulation should be given consideration in this type of construction in order to take full advantage of the insulation value of the walls. The insulation value of the walls may be largely dissipated by poorly constructed temperature-conducting roofs.

Wall Finishes. Adobe brick walls can be finished on the exterior by applying cement stucco, various types of waterproofing paints, or whitewash. Suitable expanded metal wire mesh netting should be used as reinforcing when applying the cement stuccos. If the walls are to be painted directly on the stucco, the joints should be well pointed. If desired, a smooth wall texture adobe mortar may be used as a plaster over the brick prior to the painting. This adobe plaster will adhere to the brick surface without the use of metal lath or other reinforcing.

For interior finishes, the walls can be given a mud plaster finish followed by painting, or lime plasters may be used directly on the walls without the use of reinforcing wire. Somewhat different paint formulae must be used when painting is done directly to emulsion stabilized adobe brick surfaces due to the asphalt content.

Floor. As adobe brick dwellings are generally one-story type without a basement or cellar, much of the floor area is directly on the ground floor. This permits the use of stabilized adobe soil as a base for tile, brick, or concrete, and insures a warmer floor.

The stabilized adobe base can be constructed in place as a monolith, or built by laying sun dried adobe brick in stabilized adobe mortar and granting all joints with the mortar. After thorough drying, an application of emulsified asphalt, followed by a covering of sand, provides the waterproof membrane upon which to construct either tile, brick, or concrete surface. Of course, this type of floor can not be used when houses are provided with basements. If wood floors are used, they must be supported on joists above ground level, and openings must be left in the foundation to prevent dry rot.

The preceding brief description of the most important requirements of adobe construction reveals that this type of construction requires good planning, competent workmanship, considerable time, and some fairly costly materials. It also intimates the necessity of using skilled and experienced workmen, familiar with approved adobe construction.

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ADOBE CONSTRUCTION COSTS

The principal reason for introducing an analysis of adobe construction costs into this report, is because the feasibility of its use undoubtedly depends on the cost of adobe compared with that of frame construction. The simplest way of determining which type of construction is most economical to build is, first, to ascertain what changes in dimensions are necessary to adapt a typical plan for frame construction to adobe construction, and second, to eliminate from consideration the items in both types of construction that are identical. Then costs of items not common to both types may be compared.

To apply this comparison to a specific case, diagram 3 b will serve, as it is a one-story house containing three bedrooms and bathroom space. The outside dimensions of this house plan are 34' x 24', with an extension 8' x 15'. These dimensions converted into square feet total 936. The thickness of the outside walls and the partitions of a frame house are substantially the same, that is about six inches. The minimum thickness of the outside walls, not over 10' high, of a one story adobe house is one foot. Due to the height of the gable end walls, the attic space therefore would have to be frame construction, unless the end walls of the first story increased to 18" in thickness. Thus for purposes of computation, it will be assumed that all the exterior walls are 12" thick. Partitions, or interior walls will be 10" thick with the exception of the main longitudinal partition. This is a bearing partition, and therefore its minimum thickness should be 12 inches.

In order to maintain the minimum space requirements, the outside dimensions of this 3 b house will have to be increased to allow for the added thickness of the interior and exterior walls. Allowing for these added thicknesses, the outside dimensions thus become 37' x 26' for the main area and 9' x 16'-8" for the addition. This totals 1112 sq. ft. or an increase of 176 sq. ft. over the area of a frame house with identical interior space.

Certain items in the construction of house 3 b are identical for both frame and adobe construction, such as the number of doors, and windows, the chimney, the electric wiring, the shingles, kitchen cabinets, interior painting, and the plumbing. Other items will differ substantially. In order to simplify the analysis, a tabulation showing the percentages and amounts of all the items of construction of a 3 b frame house, are shown below. Those items and the costs thereof, which will be the same whether

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the house is built of adobe or frame, are carried into a third column headed "ADOBE". Then attention can be centered on those items in adobe construction for which costs are not yet determined.

	FRAME		ADOBE
	Percent	Amount	
1. Excavation and Backfill	1.3	$ 33.22	$
2. Footings, walls and piers	5.6	143.08	
3. Studs, sills and plates	5.0	126.47	
4. Rough flooring, joists & roof rafters	10.2	261.89	261.89
5. Chimney and flashings	1.7	43.44	43.44
6. Sheathing and siding	10.8	275.94	
7. Roofing (shingles)	3.1	79.20	79.20
8. Interior wall finish (lath & Plaster)	7.2	183.96	
9. Ceiling finish	5.6	143.08	143.08
10. Finished floor	4.3	109.86	109.86
11. Doors, Windows and Screens	11.5	293.00	293.00
12. Miscellaneous Millwork & Trim	4.9	124.90	
13. Kitchen Cabinet (8½ feet)	2.5	65.00	65.00
14. Hardware	2.5	63.87	63.87
15. Electrical	3.4	86.87	86.87
16. Plumbing	9.6	245.28	245.28
17. Painting (Exterior)	2.6	66.43	
18. Painting (Interior)	5.1	130.30	130.30
19. Clean up	.9	23.00	23.00
20. Contingencies	2.2	56.21	56.21
Totals	100.00	$2555.00	$1601.00

In order to complete the cost estimate of the adobe 3 b house, the cost of items 1, 2, 3, 6, 8 and 17 will have to be determined, or the costs of substituting items, such as adobe walls for items 3 and 6.

Items 1 (excavation and backfill And 2 (foundation walls). Due to the added weight of the adobe walls and to prevent cracking caused by uneven settling; concrete foundations or Portland cement masonry walls will have to be provided for all exterior and interior walls. Also due to the increase in thickness, more concrete and more excavation will be necessary. It is assumed that gravel for concrete will be more conveniently available than stone, for masonry; therefore the costs for concrete will be used.

The thickness of all the foundation walls will have to be at least equal to the thickness of the adobe brick wall, except where a three inch bearing will have to be provided for the floor joist of each room. In some cases this 3 inch projection will have to be added to one or both sides of the foundation wall. This bearing is only supplied when wood floors are contemplated. The estimated cost of floors other than wood will be presented later, showing at the same time a reduction in the amount of concrete.

Item 1 (Excavation). Assuming foundation walls of the same depth above and below grade as specified for the frame house, and also using a wooden floor, the excavation increases from 6 cubic yards to about 22 cubic yards, at an estimated cost of $66.00. This includes laying out the foundation and staking lines and grades.

the house is built of adobe or frame, are carried into a third column headed "ADOBE". Then attention can be centered on those items in adobe construction for which costs are not yet determined.

	FRAME		ADOBE
	Percent	Amount	
1. Excavation and Backfill	1.3	$ 33.22	$
2. Footings, walls and piers	5.6	143.08	
3. Studs, sills and plates	5.0	126.47	
4. Rough flooring, joists & roof rafters	10.2	261.89	261.89
5. Chimney and flashings	1.7	43.44	43.44
6. Sheathing and siding	10.8	275.94	
7. Roofing (shingles)	3.1	79.20	79.20
8. Interior wall finish (lath & Plaster)	7.2	183.96	
9. Ceiling finish	5.6	143.08	143.08
10. Finished floor	4.3	109.86	109.86
11. Doors, Windows and Screens	11.5	293.00	293.00
12. Miscellaneous Millwork & Trim	4.9	124.90	
13. Kitchen Cabinet (8½ feet)	2.5	65.00	65.00
14. Hardware	2.5	63.87	63.87
15. Electrical	3.4	86.87	86.87
16. Plumbing	9.6	245.28	245.28
17. Painting (Exterior)	2.6	66.43	
18. Painting (Interior)	5.1	130.30	130.30
19. Clean up	.9	23.00	23.00
20. Contingencies	2.2	56.21	56.21
Totals	100.00	$2555.00	$1601.00

In order to complete the cost estimate of the adobe 3 b house, the cost of items 1, 2, 3, 6, 8 and 17 will have to be determined, or the costs of substituting items, such as adobe walls for items 3 and 6.

Items 1 (excavation and backfill) And 2 (foundation walls). Due to the added weight of the adobe walls and to prevent cracking caused by uneven settling, concrete foundations or Portland cement masonry walls will have to be provided for all exterior and interior walls. Also due to the increase in thickness, more concrete and more excavation will be necessary. It is assumed that gravel for concrete will be more conveniently available than stone, for masonry; therefore the costs for concrete will be used.

The thickness of all the foundation walls will have to be at least equal to the thickness of the adobe brick wall, except where a three inch bearing will have to be provided for the floor joist of each room. In some case this 3 inch projection will have to be added to one or both sides of the foundation wall. This bearing is only supplied when wood floors are contemplated. The estimated cost of floors other than wood will be presented later, showing at the same time a reduction in the amount of concrete.

Item 1 (Excavation). Assuming foundation walls of the same depth above and below grade as specified for the frame house, and also using a wooden floor, the excavation increases from 6 cubic yards to about 22 cubic yards, at an estimated cost of $66.00. This includes laying out the foundation and staking lines and grades.

Item 2 (Foundations). The amount of concrete increases from 11 cu. yds. for the frame house to 39 cu. yds. for the adobe walls. The interior wall foundations are figured at a foot less in depth than those of the exterior walls. The cost of this item thus becomes $468.00 or $12.00 per cubic yard.

Item 3 (Adobe brick and wall construction). To lay up the walls of a 3 b house, three different sized bricks, 10"x12"x4", 12"x12"x4", 12"x18"x4", will have to be used so that in the event the walls are left unplastered, the exposures of the bricks in the 10", 12" and 18" walls are the same. If walls are to be plastered a brick 10"x12"x18" can be used for all walls. The volume of all walls exclusive of openings will be approximately 2760 cubic feet. Allowing on an average 2.6 bricks to the cubic foot it will require about 7000 bricks. The amount of asphalt emulsion used to stabilize this amount of adobe brick, at one half gallon per cubic foot, will be about 1400 gallons, or 6 tons. The cost of the emulsion F.O.B. nearest shipping point in 50 gallon drums is at present about nineteen cents per gallon, allowing for the refund of $1.00 for returned drums. Thus the total cost of emulsion, plus allowing a hauling charge of about $50.00, per 3 b house would be approximately $312.00. About ten bales of chopped straw at $1.00 per bale, and perhaps 20 cu. yds. of sand at $2.00 per yard will also be necessary. These items depend on length of haul and therefore vary. Using three unskilled laborers (2 mixing and 1 at wheelbarrow) at fifty cents per hour, and one skilled laborer at seventy-five cents per hour, the cost of making the brick at the rate of 1000 per day would be $18.00 per thousand or $126.00 for 7000 bricks. To lay the brick at a rate of 1000 bricks per day, using two unskilled laborers (for carrying bricks to the layer) at fifty cents per hour and two skilled laborers (one mixing mortar, one laying) at seventy-five cents per hour, would be $20.00 per thousand, or $140.00 for the 7000. A power driver plaster mixer probably could be rented for $5.00 per day or $35.00 for the seven day period to make the brick. Therefore the total cost of the 7000 stabilized brick, made and laid in the wall, would be $312.00 for asphalt emulsion, $35.00 for the mixer, $10.00 for straw, $40.00 for sand, $10.00 for wire reinforcing, $126.00 for making the bricks and $140.00 for laying. This totals $673.00. This estimate is based on the assumption that the brick are made on the site where the house is to be built. If the bricks require hauling to the building site, allowance of $4.00 per ton must be added for loading, hauling and unloading. The operation of handling about 100 tons of this material is a considerable cost in itself.

Item 2 (Foundations). The amount of concrete increases from 11 cu. yds. for the frame house to 30 cu. yds. for the adobe walls. The interior wall foundations are figured at a foot less in depth than those of the exterior walls. The cost of this item thus becomes $460.00 or $12.00 per cubic yard.

Item 3 (Adobe brick and wall construction). To lay up the walls of a 3 b house, three different sized bricks, 10"x12"x4", 12"x12"x4", 12"x18"x4", will have to be used so that in the event the walls are left unplastered, the exposures of the bricks in the 10", 12" and 18" walls are the same. If walls are to be plastered a brick 10"x12"x18" can be used for all walls. The volume of all walls exclusive of openings will be approximately 2760 cubic feet. Allowing on an average 2.6 bricks to the cubic foot it will require about 7000 bricks. The amount of asphalt emulsion used to stabilize this amount of adobe brick, at one half gallon per cubic foot, will be about 1400 gallons, or 6 tons. The cost of the emulsion f.o.b. nearest shipping point in 50 gallon drums is at present about nineteen cents per gallon, allowing for the refund of $1.00 for returned drums. Thus the total cost of emulsion, plus allowing a hauling charge of about $50.00, per 3 b house would be approximately $312.00. About ten bales of chopped straw at $1.00 per bale, and perhaps 20 cu. yds. of sand at $2.00 per yard will also be necessary. These items depend on length of haul and therefore vary. Using three unskilled laborers (2 mixing and 1 at wheelbarrow) at fifty cents per hour, and one skilled laborer at seventy-five cents per hour, the cost of making the brick at the rate of 1000 per day would be $18.00 per thousand or $126.00 for 7000 bricks. To lay the brick at a rate of 1000 bricks per day, using two unskilled laborers (for carrying bricks to the layer) at fifty cents per hour and two skilled laborers (one mixing mortar, one laying) at seventy-five cents per hour, would be $20.00 per thousand, or $140.00 for the 7000. A power driven plaster mixer probably could be rented for $5.00 per day or $35.00 for the seven day period to make the brick. Therefore the total cost of the 7000 stabilized brick, made and laid in the wall, would be $312.00 for asphalt emulsion, $35.00 for the mixer, $10.00 for straw, $40.00 for sand, $10.00 for wire reinforcing, $126.00 for making the bricks and $140.00 for laying. This totals $673.00. This estimate is based on the assumption that the brick are made on the site where the house is to be built. If the bricks require hauling to the building site, allowance of $4.00 per ton must be added for loading, hauling and unloading. The operation of handling about 100 tons of this material is a considerable cost in itself.

After the walls are leveled off at the proper height the concrete or wood plate must be added to the entire perimeter of the exterior walls. This will cost approximately $52.00 extra. Thus the completed walls including plate would total $725.00 excluding truck hauling the bricks.

Item 6 (Exterior wall finish). If it is desired to plaster the exterior wall surfaces of approximately 147 square yards (deducting 10% per openings) with ½" of waterproof stucco coat on wire mesh, it will cost about $110.00. If only a smoothing or seal coat of stabilized adobe mud is applied, the cost will be about $9.00 for emulsion and $20.00 for labor, or $29.00. Whether or not the above finishes are applied the walls must be sealed to receive paint. This will affect the cost of interior painting as given below under Item 17. Using stabilized brick, the cost of plastering can be avoided.

Item 8 (Interior wall finish). The figure given for this item for frame construction will be substantially the same for adobe wall finish. In place of wood lath, wire mesh is used. However, this item can be eliminated in low cost houses and the cold water paint applied directly to the brick. If a smooth wall surface is desired, stabilized adobe plaster can be trowelled on the brick. This operation would cost approximately $60.00 ($18.00 for emulsion and $42.00 labor). It is recommended that the walls of the kitchen and bathroom be smooth coated, to facilitate cleanliness. This would involve an additional cost of $15.00 or $20.00.

Item 12 (Door and Window lintels, baseboards etc.). As solid timber or box type lintels must be provided over all door and window openings, and baseboards with floor moldings must be installed to protect the adobe walls and trim the floor, about $65.00 must be allowed for this item.

Item 17 (Exterior Painting). Before paint can be applied to the exterior surfaces of either stabilized or unstabilized brick, the surfaces must be treated. The adobe bricks should be painted and all cracks in both bricks and mortar should be sealed with adobe mud at the time the bricks are laid and while the mortar is still wet. After a period of two or three weeks, small pin cracks will appear in the mortar courses due to shrinkage. These should be "pulled together" by the application of a wet rod. The adobe walls should then be allowed a thorough drying out period of two or three months of warm weather before applying the seal coats. Immediately before the application of the seal coats the walls must be brushed down so as to remove all loose particles and dust.

The first sealer coat, consisting of one part sealer (such as Premier Sealer) one part raw linseed oil, one quarter part pine turpentine, is then

After the walls are leveled off at the proper height the concrete or wood plate must be added to the entire perimeter of the exterior walls. This will cost approximately $52.00 extra. Thus the completed walls including plate would total $725.00 excluding truck hauling the bricks.

Item 6 (Exterior wall finish). If it is desired to plaster the exterior wall surface of approximately 147 square yards (deducting 10% for openings) with ½" of waterproof stucco coat on wire mesh, it will cost about $110.00. If only a smoothing or seal coat of stabilized adobe mud is applied, the cost will be about $9.00 for emulsion and $20.00 for labor, or $29.00. Whether or not the above finishes are applied the walls must be sealed to receive paint. This will affect the cost of interior painting as given below under Item 17. Using stabilized brick, the cost of plastering can be avoided.

Item 8 (Interior wall finish). The figure given for this item for frame construction will be substantially the same for adobe wall finish. In place of wood lath, wire mesh is used. However, this item can be eliminated in low cost houses and the cold water paint applied directly to the brick. If a smooth wall surface is desired, stabilized adobe plaster can be troweled on the brick. This operation would cost approximately $60.00 ($18.00 for emulsion and $42.00 labor). It is recommended that the walls of the kitchen and bathroom be smooth coated, to facilitate cleanliness. This would involve an additional cost of $15.00 or $20.00.

Item 12 (Door and Window Lintels, baseboards etc.). As solid timber or box type lintels must be provided over all door and window openings, and baseboards with floor moldings must be installed to protect the adobe walls and trim the floor, about $65.00 must be allowed for this item.

Item 17 (Exterior Painting). Before paint can be applied to the exterior surfaces of either stabilized or unstabilized brick, the surfaces must be treated. The adobe bricks should be painted and all cracks in both bricks and mortar should be sealed with adobe mud at the time the bricks are laid and while the mortar is still wet. After a period of two or three weeks, small pin cracks will appear in the mortar courses due to shrinkage. These should be "pulled together" by the application of a rat rod. The adobe walls should then be allowed a thorough drying out period of two or three months of warm weather before applying the seal coats. Immediately before the application of the seal coats the walls must be brushed down so as to remove all loose particles and dust.

The first sealer coat, consisting of one part sealer (such as Promar Sealer) one part raw linseed oil, one quarter part pine turpentine, is then

applied rather heavily and within an hour or before the first coat has lost its "tackiness", the second coat is applied. The second coat is made up of one part sealer, one part linseed oil and a trace of paint. The first coat acts as a penetrating agent and at the same time provides a bond for the second coat which in turn acts as a sealer and a bond for paint application. It is important that the second coat be applied before the first coat sets. Two or three days later, the usual paint coats can be applied.

As frame structures do not require preliminary treatment before paint is applied, the painting of exterior walls of adobe is a more expensive operation. Thecost of the two seal coats is approximately $2.25 per square. Allowing for the increase in the area of the adobe structure over the frame, the estimated cost for the exterior of a 3 b adobe house would be $102.43.

SUMMARY OF COST OF ADOBE CONSTRUCTED 3 b HOUSE

Inserting the above estimated costs for the items missing from the adobe column on page 8, the total estimated cost of a 3 b house constructed of stabilized adobe bricks is as follows:

1.	Excavation	$ 66.00
2.	Foundation	468.00
3.	Adobe brick and wall construction	725.00
4.	Rough flooring, joists & roof rafters	261.89
5.	Chimney and flashings	43.44
6.	Exterior wall finish (minimum)	29.00
7.	Roofing shingles	79.20
8.	Interior wall finish	20.00
9.	Ceiling finish	143.08
10.	Finished floor	109.86
11.	Doors, windows, screens	293.00
12.	Lintels and miscellaneous trim	65.00
13.	Kitchen cabinet (8½ feet)	65.00
14.	Hardware	63.87
15.	Electricals	86.87
16.	Plumbing	245.28
17.	Painting (Exterior)	101.43
18.	Painting (Interior)	130.30
19.	Clean-up	23.00
20.	Contingencies	56.21
	Total	$3075.43

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As frame structures do not require preliminary treatment before paint is applied, the painting of exterior walls of adobe is a more expensive operation. The cost of the two seal coats is approximately $2.25 per square. Allowing for the increase in the area of the adobe structure over the frame, the estimated cost for the exterior of a 3 b adobe house would be $102.63.

SUMMARY OF COST OF ADOBE CONSTRUCTED 3 b HOUSE

Inserting the above estimated costs for the items missing from the adobe column on page 8, the total estimated cost of a 3 b house constructed of stabilized adobe bricks is as follows:

1.	Excavation	$ 66.00
2.	Foundation	468.00
3.	Adobe brick and wall construction	725.00
4.	Rough flooring, 3-plate & roof rafters	261.89
5.	Chimney and flashings	43.44
6.	Exterior wall finish (minimum)	29.00
7.	Roofing shingles	79.20
8.	Interior wall finish	20.00
9.	Ceiling finish	143.08
10.	Finished floor	109.86
11.	Doors, windows, screens	293.00
12.	Lintels and miscellaneous trim	65.00
13.	Kitchen cabinet (8½ feet)	65.00
14.	Hardware	63.87
15.	Electricals	86.87
16.	Plumbing	245.28
17.	Painting (Exterior)	103.43
18.	Painting (Interior)	130.30
19.	Clean-up	23.00
20.	Contingencies	56.23
	Total	$3075.43

It would therefore cost about 20.4 per cent more to construct a 3 b house of adobe bricks than it would to build it of wood.

This conclusion is borne out by letters received from C.D.Dart, Acting Director of Kern County Work Relief Department, Bakersfield, California, and the Chief Underwriters of the Federal Housing Administration offices at Phoenix, Arizona, and San Francisco, California. These letters, copies of which are herewith attached, were in response to the inquiry, "which type of construction, in their experience, was the least expensive." Cost estimates in both cases are based on use of approved standards of construction, and upon payment for competent labor. Standards of quality might be abandoned in either case, or jerry building allowed, then in either case the cost would be less and the structure accordingly depreciated in durability, appearance, and utility. It is felt, however, that the costs shown in analysis above, are for buildings of approximately equal value, constructed under generally similar conditions.

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